New Scientist

WEEKLY 18 May 2024

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NS Live

DNA detective

Hear geneticist Turi King discuss the use of DNA in genealogy and forensics at New Scientist Live on 12 October at London's ExCeL Centre. Find out how the popularity of genetic testing, as people go in search of their ancestry, has created databases that allow us to answer previously impossible questions.

newscientist.com/nslmag

Tour

Rewilding Weekender: Coombeshead, England

Discover how nature is making a comeback in the scenic Devon countryside. Accompanied by *New Scientist* staff writer Graham Lawton, you will learn how rewilding allows nature to take care of itself. You will take part in a walking safari, see animals in a breeding and reintroduction centre and go beaver watching. This tour runs from 16 to 18 August and costs £749.

newscientist.com/tours

Podcast

CultureLab

How do we understand the stakes of climate change and come to terms with the uncertainty of our situation? Journalist and Pulitzer prizewinning author Elizabeth Kolbert breaks things down for us alphabetically as she dissects the narratives around climate change, from sobering facts about our warming planet to innovations to fuel our optimism.

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SHUTTERSTOCK/VACLAV SEBEK

Savannah hypothesis Did grasslands really drive our evolution?

MARC QUINN STUDIO/KEW

Light Into Life A Kew Gardens exhibition melds plants and metal

Video

Natural reflection

Light Into Life is an exhibition by Marc Quinn at Kew Gardens in London that showcases metal sculptures around the gardens alongside his paintings, drawings and evocative "frozen works". The mirrored effect of the sculptures blurs the boundary between viewer and landscape, offering a chance to appreciate the many ways that plants serve our lives.

youtube.com/newscientist

Newsletter

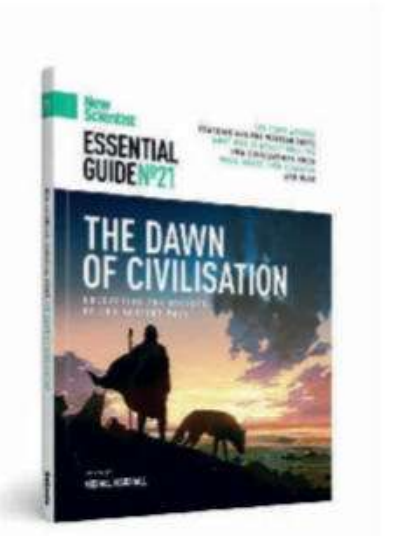
Our Human Story

Michael Marshall looks at the big picture of how and why hominins like us evolved. A new idea places competition between *Homo* species as the driver. But it doesn't rule out older ideas like the "savannah hypothesis", whereby expanding grasslands forced our ancestors to come down from the trees.

newscientist.com/our-human-story

Podcast

"Climate change is a freight train coming at us, but we seem intent on just standing on the tracks"



Essential guide

Where are the origins of humanity? When did civilisation begin and what does the future of society hold? Uncover the secrets of the past in this *New Scientist Essential Guide* covering all that we know about the arc of human ingenuity. Now available to read in the app or buy in print from our online shop.

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Wisdom about age

Prejudices about the elderly are unhealthy, in more ways than you might think

"I HOPE I die before I get old," sang *The Who*'s Roger Daltrey in the 1965 hit single *My Generation*, which gave voice to the frustrations of a youth yearning for liberation from their fusty elders. Daltrey's wish didn't come true – he is now 80 and presumably hoping to die when he is even older. But while many societal views have changed dramatically for the better since 1965, negative views of ageing that were acceptable then are largely still acceptable today.

Ageism is arguably the last widespread prejudice in Western societies. According to another group called the WHO – the World Health Organization – about half of people globally hold negative views of the elderly, including many older people themselves. It is an irrational prejudice, not least because it is based on lazy stereotypes, but also because the elderly are the one marginalised group we will all eventually join, if we are lucky enough.

It is self-defeating too. As we report on page 32, ageism doesn't just make young people look down on their elders,

"Younger people who are ageist may be setting themselves up for poorer health when older"

it also causes the elderly to look down on themselves, narrowing their horizons and exacerbating illnesses that can come with advancing years. There is even evidence that younger people who are ageist are setting themselves up for poorer health when they themselves are older.

Huge efforts have gone into ensuring that prejudices based on ethnicity, gender, sexuality, physical and mental capacity, body shape, nationality and more are unacceptable. There is still a way to go on all of these. But progress since the days of *My Generation* has made our societies richer, more tolerant, more diverse and more creative. Eradicating ageism would multiply these gains and, as it turns out, make us collectively healthier too.

There are many pioneering organisations trying to address the scourge of ageism, and all power to them. Daltrey himself is now an anti-ageism campaigner, having seemingly changed his tune when it comes to statements about the elderly. That's a campaign we should all be behind – no matter our age. ▮

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SEAN PARKER

Astronomy

The northern lights go south

The dazzling aurora borealis, or northern lights, seen in much of the northern hemisphere on 10 May was caused by the sun blasting out plasma that led to a geomagnetic storm. The lights ventured to much lower latitudes than usual, including Tucson, Arizona (pictured). Further auroras are possible in the coming months as the sun approaches the peak of its 11-year cycle of activity.

Astrophysics

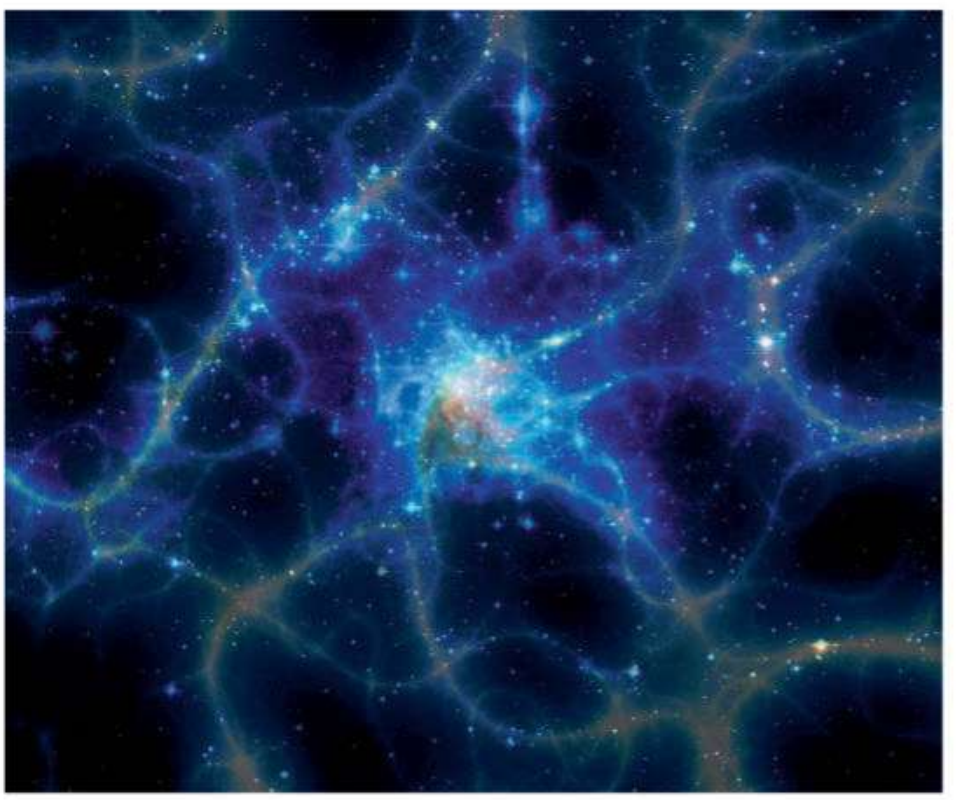
‘Dark radiation’ may solve cosmic clash

Surprising recent measurements hint that the universe isn’t expanding in the way we had thought. This could be explained by a theoretical radiation that is like invisible light, finds **Leah Crane**

THERE are hints that the universe is behaving unexpectedly, and astrophysicists are racing to explain why. Their ideas to account for this surprising result include allowing dark matter and dark energy to interact, and arguing for the existence of strange “dark radiation” that is like regular light but invisible.

In April, researchers using the Dark Energy Spectroscopic Instrument (DESI) in Arizona released the biggest 3D map of the universe ever created, and it hinted that we may have been wrong about dark energy – the mysterious force causing the accelerating expansion of the universe.

The data contained indications that dark energy may change over time, meaning the rate of expansion of the universe isn’t accelerating as smoothly as we thought. This runs contrary to the standard model of cosmology.



JVPHOTO/ALAMY

An unseen web of dark energy is thought to pervade the universe

Huge implications

Dark energy is thought to make up nearly 70 per cent of the cosmos, so if its behaviour really is changing as time passes, there could be huge implications for our understanding of the universe.

Since the DESI data came out, researchers have been working on ways to explain the apparent changes in the universe’s expansion rate. Dark energy isn’t directly observable, so there are several options that could fit. “There are many ways to potentially solve this – too many,” says Miguel Sabogal García at the Federal University of Rio Grande do Sul in Brazil. “Each one has its advantages.”

One solution suggested by Sabogal García and his colleagues involves letting dark energy interact with dark matter, a mysterious form of matter we can’t see and that is far more plentiful than standard matter. This interaction is forbidden by the standard model, but if energy could flow from the universe’s dark matter to its dark energy – essentially converting the former to the latter – the researchers’ simulations showed that this would match the DESI measurements (arXiv, doi.org/mv3h). Yet, the mechanism for such an energy transfer isn’t clear.

One upside of this solution is that it could also help resolve a long-standing cosmic disparity called the Hubble tension. This arises from a lack of agreement in the two main ways we gauge the expansion rate of the cosmos. Measurements of this made by analysing nearby galaxies (known as “local” measurements) give an expansion rate, or Hubble constant, that is slightly higher than the one we get by analysing the light left over from the big bang, called the cosmic microwave background (CMB).

However, the CMB measurements require using a theoretical model of the cosmos to extrapolate the observations forward in time from the big bang. Sabogal García and his colleagues’ proposal that dark matter and dark energy interact suggests we might need to change that theoretical model. This would bring the CMB measurement of the Hubble constant closer to aligning with the local measurements. Recent observations have also suggested that the local value may be slightly lower than cosmologists thought, so García’s approach could see the tension dealt with.

“If these modifications of dark energy are confirmed, it could imply a breakdown in the laws of physics”

Interacting dark energy isn’t the only way to do that. Itamar Allali at Brown University in Rhode Island and his colleagues have come up with another way to explain the DESI data while relaxing the Hubble tension: dark radiation.

Regular radiation is made up of massless particles called photons, and dark radiation would be the same, except the dark photons it is made from wouldn’t be visible or interact much with regular matter. “The data do not rule out dark radiation like previous datasets seemed to – and we even see a slight preference for it,” says Allali. “If you have more radiation, the expansion is faster in the early universe.” This could create the changes that the DESI researchers chalked up to possible shifts in dark energy (arXiv, doi.org/mv3g).

While still just theoretical, dark radiation may also be a simpler solution than arguing for changes in the behaviour of dark energy. “If these modifications of dark energy were confirmed, they could imply a breakdown in the laws of physics,” says Alessio Notari at the University of Barcelona in Spain, part of Allali’s team. “What we did is much more conservative. It’s just adding an extra ingredient that’s similar to things we already observe.”

For now, both models seem to fit the DESI data, and there will almost certainly be more that do. “It is compelling to test one’s favourite exotic model, and the current results allow for a plethora of models which could fit the data,” says Alkistis Pourtsidou at the University of Edinburgh, UK. “However, other than the [current standard model of cosmology], no other dark energy model really stands [up] from a fundamental physics point of view.”

We need more data before we can pass a conclusive judgement on the standard cosmological model, says Shahab Joudaki at the University of Portsmouth, UK. ▮

Palaeoanthropology

Oldest known human viruses found hidden within Neanderthal bones

James Woodford

GENETIC sequences from three common viruses that plague humanity today have been isolated from the remains of Neanderthals who lived more than 50,000 years ago.

Marcelo Briones at the Federal University of São Paulo, Brazil, who found the viruses, says it may be possible to synthesise them and infect modern human cells with them in the lab. "These *Jurassic Park*-like viruses could then be studied for their reproductive and pathogenic traits and compared to present-day counterparts," he says.

Briones and his colleagues analysed DNA from the skeletons of two male Neanderthals (*Homo neanderthalensis*) found in Chagyrskaya cave in Russia. They identified the remnants of an adenovirus, which causes cold symptoms in modern humans; herpesvirus, which can result in cold sores; and the sexually transmitted papillomavirus, which can cause genital warts and cancer (bioRxiv, doi.org/mv3c).

They are the oldest human viruses so far discovered, superseding a 31,000-year-old virus found in *Homo sapiens* teeth recovered from north-east Siberia.

Briones says that by comparing the genetic sequences with modern viruses, the team has ruled out the possibility that the viruses came from contemporary humans who may have handled the remains or predators that may have fed on them.

"Taken together, our data indicate that these viruses might represent viruses that really infected Neanderthals," he says.

Some researchers have speculated that viruses may have played a role in the Neanderthals' extinction. "To support their provocative and interesting hypothesis, it would be necessary to prove that at least the genomes of these viruses can be found in Neanderthal remains," says Briones. "That is what we did." But the team's results just add weight to the possibility, they can't confirm it, he says.

The fact that a single Neanderthal could be infected with three viruses isn't surprising, he says, since humans today are infected by about 10 different viral species, on average, during their lifespan.

Sally Wasef at Queensland University of Technology in Australia says the research suggests there is a high chance of further discoveries about past diseases that may have affected anatomically modern humans and our extinct human relatives.

However, the study of ancient viruses remains a new field that needs more exploration, she says. "The current tools used to authenticate ancient DNA results from humans might not apply to viruses, which have shorter DNA strands by default."

Briones's goal of recreating the ancient viruses will prove challenging, she adds. "I am sceptical that this could be achieved given the lack of full understanding of how the viruses' DNA is damaged and how to reconstruct the recovered pieces into a full viral genome. Also, the host-virus interaction, especially in a completely different environment, is something to consider." ▮

Reconstruction of a Neanderthal man based on fossils

S. ENTRESSANGLE/E. DAYNES/SCIENCE PHOTO LIBRARY

Health

Edible gel offers rapid solution to intoxication

COULD an ingestible gel prevent drunkenness, sober you up or stop you getting a hangover? That is the hope for a gel based on a milk protein that has been shown to drastically cut the level of alcohol in the blood of intoxicated mice.

There are existing treatments for severe intoxication, such as injecting certain enzymes, however they are often invasive, says Raffaele Mezzenga at ETH Zurich in Switzerland.

Looking for an alternative, Mezzenga and his colleagues have combined nanofibres made of a whey protein called beta-lactoglobulin – a byproduct of cheese-making – with iron particles. This created an ingestible gel that mimics the structure of an enzyme that causes the body to break down alcohol into acetic acid, which plays a role in the metabolism of fat and carbohydrates, rather than the more toxic chemical acetaldehyde, which can trigger negative health outcomes and contributes to hangovers.

A group of mice were given unlimited access to ethanol, the type of alcohol found in drinks, for 10 days. When the researchers then gave the mice the gel, their blood alcohol levels fell by just over 55 per cent after 4 hours. This was much faster than the reduction seen in another group of intoxicated mice that weren't given the gel, says Mezzenga. Acetaldehyde levels also drastically declined in the first group after these mice ate the gel (*Nature Nanotechnology*, doi.org/mv4x).

In another part of the experiment, the team found that mice that both consumed alcohol every day for 10 days and ate the gel over the same period had healthier organs than those that didn't get the gel.

"Alcohol doesn't cross into the bloodstream and you don't suffer from the side effects"

Their organs, such as their livers, were nearly indistinguishable from those of mice that didn't drink alcohol, says Mezzenga.

"If you ingested this gel before you drink, most of the alcohol you drink is converted into acetic acid," he says. "That means alcohol doesn't cross into the bloodstream and you don't suffer from the side effects."

The team now hopes to test the gel's efficacy in people. "I think people who have alcohol addiction will greatly benefit from this as a therapeutic treatment," says Mezzenga. It could also help people drink alcohol without becoming intoxicated, he says. ▮

Chen Ly

Space

‘Impossible’ star mystery resolved by three-body solution

Jonathan O’Callaghan

THE conundrum of a star that seemed too small to exist has been solved by the detection of another star hiding in the same system.

In 2019, astronomers announced the discovery of a system called KIC 8145411 in which a white dwarf – the dull, compact remnant left behind after certain stars exhaust their nuclear fuel – was orbiting a sun-like star every 450 days. The system is a rare example of a self-lensing binary, where the gravitational heft of the compact white dwarf magnifies the light of its companion star relative to us, allowing astronomers to measure the dwarf’s mass.

They found that the white dwarf was just a fifth the mass of our sun, which is extremely low for such a star, and was previously only seen in situations where the dwarf tightly orbits another star that saps mass from it. In KIC 8145411, the white dwarf orbits at a distance slightly greater than that between Earth and our sun (1 astronomical unit, or AU), which is too far for the larger star to chip away at the dwarf. Astronomers concluded that this impossible star shouldn’t exist.

Now, Natsuko Yamaguchi at the California Institute of Technology and her colleagues have taken another look, using the Palomar Observatory in California. They found that the system contains another sun-like star, orbiting the other two at about 700 AU away. Factoring this in, the team calculated the mass of the white dwarf as about half that of our sun (arXiv, doi.org/mv39). “It’s no longer impossible,” says Yamaguchi.

The hidden star discovery hints that other supposed binary systems may host extra stars, confusing some calculations for working out stellar masses. “This situation where you have two bright stars but you think it’s one is probably not that uncommon,” says Yamaguchi. ▮

Analysis Mental health

Does using the internet make us happier or sadder? A large study suggests that access to the internet is linked to our life satisfaction, but questions remain, says **Clare Wilson**

GROWING access to the internet is linked with better well-being around the world, a large study has concluded. The finding seems to be at odds with concerns that smartphones have led to a flood of mental health problems. So, where does the truth lie?

Concerns over excessive use of phones may seem a modern phenomenon, but they echo similar fears over past tech trends, such as that people would get hooked on computer games or TV, says Andrew Przybylski at the University of Oxford.

Yet the widespread adoption of smartphones does seem a more extreme social phenomenon. It has also coincided with rising levels of mental health problems in younger people in recent years, especially teenage girls.

Most studies that have tried to investigate whether the two trends are linked have looked at people in Western countries. Instead, Przybylski and his colleague Matti Vuorre at Tilburg University in the Netherlands used data from the long-running Gallop World Poll, which included questions about the use of the internet and internet-connected phones.

JOE RAEDLE/GETTY IMAGES

What we see on our smartphones influences our lives

2m+

Number of people polled between 2006 and 2021

The survey asked people about eight indicators of well-being, including life satisfaction and positive or negative experiences, as well as collecting demographic data. The researchers analysed figures for more than 2 million people from 168 countries between 2006 and 2021.

The pair carried out more than 30,000 analyses for each country and year. The vast majority found that people were more likely to have higher well-being if they had internet access. These positive associations remained even when the analyses were adjusted to account for people being more likely to use the internet if they had a higher income or level of education (*Technology, Mind, and Behavior*, doi.org/mv6v).

While this kind of analysis couldn’t prove that internet access increases people’s happiness, it may help them make friends or have access to more job opportunities, says Przybylski. “These are social technologies.”

The findings are unlikely to settle any arguments, though. For one thing, the primary concern about the harms of social media relates to its impact on children, teenagers and young adults, such as whether it may facilitate bullying, promote unrealistic body images or allow radicalisation.

The Gallop poll covered people aged between 15 and 99, so it is possible that any harms specific to younger people were masked by the fact that older people could be more resilient.

Another issue is that the survey questions about internet use required a simple yes or no answer – they didn’t ask people how long they spent using it. It is possible that some access to the internet is better for your mental health than none, but that excessive use is harmful, says Andres Roman-Urrestarazu at the University of Cambridge. “I’m not sure the type of measurements they’re using are adequate.”

So, the new findings may tell us that a farmer in Kenya becomes happier when they can use their phone to check which markets will give them the best price for their produce, but it doesn’t tell parents in the UK if they should let their pre-teen start using WhatsApp.

Nevertheless, the findings bring a new slant to the debate about how the internet is changing the world and is a reminder that new media can be beneficial in many countries. “It really does open you up to a lot of good stuff, [as well as] scams and different types of exploitation,” says Przybylski. ▮

Evolution

Anthropological accounts support the idea that humans evolved to chase down prey

Michael Le Page

WE WERE born to run. The energy gained from food by pursuing prey over long distances can far exceed that spent running, researchers have found, strengthening the argument that humans evolved for endurance running.

Humans are exceptional endurance athletes, capable of outrunning even animals such as horses over distances of tens of kilometres. We have muscles built for stamina rather than power, and can keep cool by sweating.

"These traits can only be explained in the context of running," says Eugène Morin at Trent University in Canada. "And there are not many reasons for humans to run for long distances other than hunting."

It has been suggested that humans evolved to chase prey until the prey were unable to run any further. This idea, known as the endurance running hypothesis, is hotly debated. One criticism is that running uses a lot of energy compared with walking. Another is that there are hardly any reports of modern humans using this hunting technique, suggesting it isn't very efficient.

"There aren't many reasons for humans to run for long distances other than hunting"

So, Morin and Bruce Winterhalder at the University of California, Davis, estimated the energy expended to catch prey when persistence hunting versus the energy gained by catching prey of various sizes. Running beats walking for all but the smallest prey, according to their modelling.

That is because running doesn't use much more energy per kilometre but can greatly shorten the duration of a chase. Running 4 kilometres to catch an animal is more efficient than walking 8 kilometres, for instance.

Morin and Winterhalder also searched through accounts of various peoples written by anthropologists or missionaries from the 1500s onwards. They found around 400 descriptions of endurance hunting from all over the world, most from before 1850.

For example, an account of the Beothuk people of Newfoundland in Canada describes a lengthy pursuit of a stag. Another report describes endurance hunting of herds of goats in Hawaii.

There were also accounts from colder regions. "We hunted the moose by running him down on snowshoes, and we could run all day, such as wolves," an individual of the Gwich'in people of Alaska and Canada is reported as saying (*Nature Human Behaviour*, doi.org/mv4n).

Morin says that being able to run long distances used to be a highly valued ability, with numerous accounts of long-distance running races being part of the culture of peoples all around the world. "Something that was thought to be marginal is now shown to be a common strategy worldwide," he says.

"It's hard to argue with the results of their analysis, which clearly support other anatomical, physiological, archaeological and genetic evidence that humans evolved to run long distances to hunt," says Daniel Lieberman at Harvard University.

Henry Bunn at the University of Wisconsin-Madison says he remains sceptical of the hypothesis. He thinks the method wouldn't have worked in the bushlands where humans evolved, where hunters would quickly lose sight of fleeing prey. ▮

Zoology

Monkeys can learn to tap to the beat of the Backstreet Boys

MACAQUES can tap along to a tune, which suggests that the ability to synchronise movements with music may not be limited only to species with complex vocalisations, such as humans and some songbirds.

Vani Rajendran at the National Autonomous University of Mexico and her colleagues worked with macaque monkeys that had previously been trained to tap in time with a metronome. The idea was to see if they could also tap along to a more complex and musical beat.

First, the team trained the macaques to tap to metronome-like sequences of tones with different tempos, frequencies and volumes.

"Once they learned to tap along to these acoustically complex sounds, we presented them with real musical excerpts and found that they could tap along much like humans can," says Rajendran.

The songs played to the monkeys included *You're the First, the Last, My Everything* by Barry White, *A New England* by Billy Bragg and *Everybody (Backstreet's Back)* by Backstreet Boys.

The team ran the same tests with people and found some important differences in how humans and macaques tapped the rhythm.

Tapping to music is unnatural for the monkeys, says Rajendran, and they need training to learn it, while humans do it spontaneously. Also, monkeys don't necessarily tap at the same moments as humans would in a song, and while a person tends to consistently tap one rhythm across trials, a monkey will often tap different interpretations of the beat for the same song (bioRxiv, doi.org/mv38).

STEFAN HUWILER/IMAGEBROKER.COM GMBH & CO. KG/ALAMY

Macaques have got what it takes to swing to a beat

"However, the fact that this skill can be acquired through training has implications for our understanding of the evolutionary origins of human musicality and for our knowledge of the brain structures and connections required to be able to tap along, or dance or sing, to music," she says.

Gisela Kaplan at the University of New England in Armidale, Australia, says the study suggests human musical ability isn't so unusual. "There have to be evolutionary antecedents to matters that require the appropriate brain links," she says. "At least some primates, even when non-vocal learners, have a sense of rhythm." ▮

James Woodford

Space

A glimpse of alien civilisations?

Infrared signatures of dozens of stars hint they host structures called Dyson spheres

Jonathan O'Callaghan

IS ANYONE out there? Two surveys of millions of stars in our galaxy have revealed mysterious spikes of infrared heat. Astronomers say this could be evidence for alien civilisations harnessing energy from their stars by using vast constructions known as Dyson spheres – although they can't rule out more mundane explanations.

Proposed back in the 1960s, these spheres are hypothesised structures that would surround stars to absorb their energy, a possible means by which advanced aliens might draw huge amounts of power. If such objects exist, they should be warm enough to give off a detectable infrared glow or "technosignature".

To search for this sign, two teams of astronomers, one led by Matías Suazo at Uppsala University in Sweden and the other by Gaby Contardo at the International School for Advanced Studies in Italy, combined data from the European Space Agency's Gaia satellite with infrared survey data from ground and space telescopes.

Each team analysed 5 million stars, and both turned up signs of

DOTTED ZEBRA/ALAMY

Dyson spheres could capture energy by surrounding a star

excess infrared heat that was difficult to explain by known natural processes. "The most fascinating explanation could be actual Dyson spheres," says Suazo.

His team spotted strange signals at seven red dwarfs within 900 light years of Earth. These stars are smaller and dimmer than our sun, but appeared up to 60 times brighter in infrared than expected (arXiv, doi.org/mv6k).

This excess would have been caused by something with a temperature of up to about 25°C (77°F), consistent with what we might expect for a Dyson sphere. Up to 16 per cent of each star would have to be obscured to account for the signal, meaning it is more likely to be a variant of the idea called a Dyson swarm – a collection of large satellites orbiting a star to collect energy – if the cause is truly of artificial origin. "This isn't like a single solid shell around the star," says team member Jason Wright at Pennsylvania State University.

Contardo's results are broader, with 53 candidates found among larger stars at distances of up to 6500 light years from Earth (arXiv, doi.org/mv6m). "Both sets of candidates are interesting," she says, though inconclusive. "You need follow-up observations to confirm anything."

A possible natural explanation is that the stars are surrounded by hot, planet-forming debris discs, but most of the stars found by both teams seem too old for this. Another is that each star could be in front of a distant galaxy giving off an infrared glow.

The infrared signals could also result from an unknown natural process. "It might be something that happens very rarely, like if two planets collide and produce an enormous amount of material," says David Hogg at New York University, who worked with Contardo. "I think it's most likely to be a natural phenomenon."

The James Webb Space Telescope could reveal if the infrared heat comes from natural dusty material or something else. ▮

Agriculture

Spray on sticky oil traps insects without using toxins

STICKY traps consisting of tiny oil droplets can catch small pests on plants while leaving larger insects such as bees unharmed. The researchers who developed the product hope it will help reduce the use of chemical pesticides.

The inspiration for this came from sticky insect-trapping hairs on plants like sundews, says Thomas Kodger at Wageningen University in the Netherlands.

To find a formulation that would work with the sprayers already used by farmers, Kodger and his colleagues oxidised certain vegetable oils and mixed them vigorously with water to create tiny droplets mostly less than a millimetre in diameter. The resulting particles don't clog up sprayers, but do stick to plants for weeks. "It's literally oil, air, a little bit of heat and patience," says Kodger.

The spray-on oil works in the same way as the sticky paper traps often used to catch insects, by physically trapping tiny animals. But the small droplets don't catch bigger insects, including beneficial ones such as bees and hoverflies.

"One of the reasons larger [sticky] traps are not used in greenhouses today is because they devastate pollinators and other beneficial insects," says Kodger.

In their tests, the researchers found that after the sticky oil droplets were sprayed on plants, they caught at least five or six out of every 10 adult thrips that were put on the plants (*PNAS*, doi.org/mv42). Thrips are tiny sap-sucking insects that can damage many plants, from chrysanthemums to tomatoes.

"The sticky oil droplets caught at least five or six out of every 10 adult thrips"

The spray-on approach is even more effective when it comes to trapping thrip larvae, says Kodger. "We have recent data that shows it prevents population explosions."

For crops such as tomatoes, the idea would be to spray plants before fruits develop, but the spray is non-toxic, he says, and safer than chemical pesticides. The team plans to apply for regulatory approval in Europe within a year. ▮

Michael Le Page

Technology

Hackers can steal data by changing computer CPU speed

Matthew Sparkes

BY ALTERING the speed of a computer's processor, hackers could extract information from software that can't connect to the internet.

Some computers handle such sensitive tasks that they aren't connected to the internet to avoid hacks, a precaution known as air-gapping. But an attacker who manages to install malware on a machine like this using an infected USB stick can extract data with methods like transmitting ultrasonic noise containing encoded data via the computer's speakers.

Shariful Alam at Boise State University in Idaho and his colleagues have worked on related situations, where the computer isn't air-gapped, but certain applications are prevented from accessing the internet, while others function normally. For example, imagine an app used by bank staff to view customer accounts that is banned from internet access by a firewall, while the browser and email can work as usual.

To maintain security, such applications are designed to have no direct way of passing data between them. But Alam says you can trick these apps into communicating by encoding data in tiny fluctuations in processing power, allowing the insecure app to transmit data to remote hackers.

The researchers used a feature in Intel processors that allows the chip to be slowed to save power or sped up to handle intensive tasks. In tests, they encoded and transmitted 55.24 bits per second from one app to another – enough to encode about seven characters of text per second (arXiv, doi.org/mv33).

An Intel spokesperson told *New Scientist* that no steps would be taken to fix the issue because the method could only be used by an attacker who already has privileged access to the system, so the system is already compromised. ▮

Health

Flu vaccine for children linked to pneumonia risk for relatives

Clare Wilson

THE nasal flu vaccine for children causes a temporary rise in the number of pneumonia-causing bacteria in the nose, and in the noses of members of the child's household – but this may not actually lead to more cases of pneumonia.

In fact, given that bacterial pneumonia in older people is often triggered by a bout of flu, vaccinating children could cause fewer pneumonia cases over the flu season, because they would catch flu less often and so be less likely to pass it on.

The intranasal flu vaccine contains a live, weakened form of the virus, which multiplies inside the nose for up to two weeks, often causing cold symptoms. This is in contrast to the injected form of the vaccine, which contains virus that is completely inactivated and doesn't reproduce.

The immune response to the weakened live flu vaccine seems to hamper the immune system's ability to keep bacteria inside the nose in check.

Nasal flu vaccines are offered to children in many parts of the world

JOE RAEDLE/GETTY IMAGES

One cause of bacterial pneumonia is a microbe called *Streptococcus pneumoniae*, which is often carried harmlessly in people's noses, especially those of young children. It is only when these bacteria spread beyond the nasal passages to the lungs that they cause pneumonia.

80%

Increased chance of a child's contacts having a high density of pneumonia bacteria

It was already known that if children get flu, or receive the intranasal vaccine, pneumonia bacteria temporarily increase in their nose.

In the latest research, Jane Metz at the University of Bristol in the UK and her colleagues studied about 400 2-year-olds and their families for two months after the children received the nasal flu vaccine.

Every two weeks, the researchers took nasal swabs from the children and about two household contacts per child. In half the cases, immunisation was carried out two weeks later, so that families where the vaccine had already been given could be compared with those who hadn't yet had it.

Children who received the nasal spray were twice as likely to have a high density of pneumonia-causing bacteria two weeks after vaccination as those who hadn't had it yet.

The new finding was that the vaccinated children's household contacts were also 80 per cent more likely to have a high density of pneumonia bacteria, presumably because the children passed them on. This effect had largely gone by two weeks after the vaccine was given.

It is unclear how this affects pneumonia illness levels in the population, the researchers write (medRxiv, doi.org/mv3s).

Daniela Ferreira at the Liverpool School of Tropical Medicine in the UK says the findings suggest that children with flu are even more likely than recently vaccinated children to pass on pneumonia bacteria to their families.

"If they encounter a flu virus, the effect could very likely be much more pronounced than what we're seeing with the attenuated virus of the vaccine," she says, because the vaccine contains just a weakened version of the virus.

Some older people may wish to avoid close contact with children who have had the flu vaccine in the past two weeks, says Keith Klugman at the Bill & Melinda Gates Foundation, which funded the research.

"This is a really interesting study and I think it's an important first step," says David Cleary at the University of Birmingham, UK, but it is too soon to start changing health advice based on this, he says. ▮

Weapons

Nuclear arms risk from fusion power

The ingredients needed to make a bomb could be rapidly created by a fusion reactor

Alex Wilkins

A COUNTRY could accelerate its development of nuclear weapons by producing the necessary ingredients in a nuclear fusion reactor in as little as a few weeks.

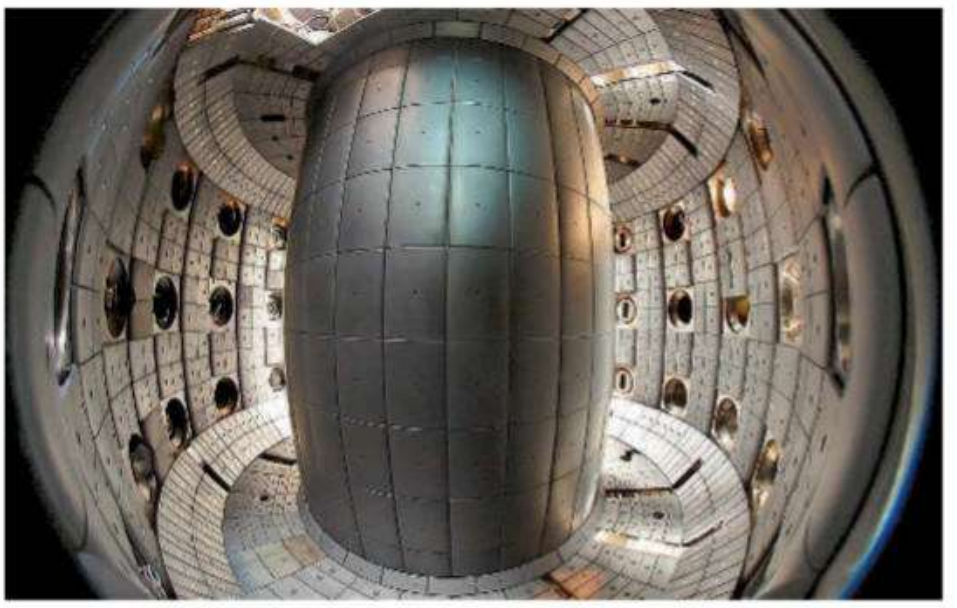
Such weapons need specific radioactive isotopes, normally uranium-235 or plutonium-239, that can start a chain reaction. This so-called fissile material is rare in nature, but can be produced artificially by a source that produces a lot of neutrons, such as a nuclear fission reactor of the kind in use today.

As such, the use of nuclear power plants can be restricted by international agreements, like the Joint Comprehensive Plan of Action, a deal designed to prevent Iran developing nuclear weapons.

However, the risk posed by future fusion reactors is less well understood. Now, John Ball at the Massachusetts Institute of Technology and his colleagues have calculated how long it would take for such a reactor to make enough fissile material for a nuclear weapon, finding that it could be much less than the minimum level of one year generally considered necessary to stop weapon proliferation.

To produce fissile material like this, a country would need a lot of non-fissile uranium-238. It would also have to place it near the fusion reactor, such as in the breeding blanket, a layer of material that is used to make further fuel for the reactor and to absorb heat.

The doughnut-shaped tokamak of a fusion reactor



EPFL/A.HERZOG

"I have all this uranium that I can't use for a weapon, but I know if I can put some extra neutrons in there, I'll get my weapons material. I just need to make some neutrons," says Ball. "Well, here's my fancy new fusion reactor that makes an incredible number of neutrons... that I can use to convert the material."

Ball and his team built a computer model of a doughnut-shaped tokamak fusion reactor and simulated how billions of neutrons produced in the reactor would breed fissile plutonium from uranium that had been placed in the breeding blanket.

They found that producing a significant amount of fissile material, defined by the International Atomic Energy Agency (IAEA) as 8 kilograms of plutonium, could be achieved in less than a year with 5 tonnes of starting uranium, or in as little as two weeks if you began with 50 tonnes (arXiv, doi.org/mv24).

Producing fissile material on shorter timescales could be a concern, says Lewis Powell at the University of Liverpool, UK, but current fission reactors can already be used to enrich nuclear material. This is prevented by international bodies such as the IAEA and agreements such as the Treaty on the Non-Proliferation of Nuclear Weapons, which enforce strict monitoring of stocks that could be used to make fissile material. These processes should also help prevent proliferation in the case of fusion reactors, says Powell. ▮

Zoology

Lavender scent helps pigs feel less stressed

FARMED pigs appear to find life less of a struggle when they can smell a pleasant odour. Spraying lavender oil into the pigs' pens leads to less aggression and self-directed tail biting, as well as more time spent lying down.

These results suggest that the plant extract might help young pigs cope better with the constraints of commercial farming, says Alberto Elmi at the University of Pisa in Italy.

"This is a starting point for future innovations and research towards sustainable, green farming systems," he says.

Many pigs on commercial farms struggle with boredom, overcrowding and the inability to move around outdoors and root at the ground, says Elmi. The stress can lead them to be aggressive towards each other and themselves.

Inhaling lavender (*Lavandula angustifolia*) essential oil has been shown to cut stress in rabbits and humans. To see if it also works with pigs, during his time at the University of Bologna, Italy, Elmi and his team tested the oil's effects on 3-month-old castrated males.

The researchers divided 84 young pigs into three groups. One group's pens were sprayed with a mix containing lavender essential oil for 10 minutes three times a day. The second group had the same routine but with an odourless spray, while a third group got no spray.

After 72 days, the pigs that inhaled the lavender scent had fewer wounds on their thighs and flanks than those in the other two groups, suggesting they were less aggressive towards each other, says Elmi. They also spent more time lying down, indicating they were calmer, and had less severe self-inflicted tail wounds.

"Pigs on farms struggle with boredom, overcrowding and the inability to move around outdoors"

By contrast, the pigs that received the spray without any lavender oil fared worse than those with no spray at all (*Research in Veterinary Science*, doi.org/mv2x).

That might be because the vaporiser vibrates and its noise upsets the pigs – an issue that could be hindering more positive effects of the lavender oil vaporisation. "We need to investigate other delivery methods," says Elmi. ▮

Christa Lesté-Lasserre

Health

Having more kids protects brain from the decline of age

Lori Youmshajekian

CHILDREN can look after their parents in later life in more ways than we thought. Parenthood seems to help protect brains against age-related decline, and the effect increases with each additional child.

In the largest ever study of brain function in parents, Edwina Orchard at Yale University and her colleagues compared MRI scans from more than 37,000 adults aged 40 to 70 in the UK Biobank study. The more children a person had, the more connectivity existed in the brain regions responsible for movement and sensation. Ageing typically decreases connectivity in these regions, meaning these individuals seemed to have a younger pattern of brain activity (bioRxiv, doi.org/mv23).

The work reveals the lasting impact of parenthood on the brain, says Orchard. She and her colleagues looked at functional MRI scans using a signal that measures how active a region of the brain is across time. The measurements had been taken at rest, meaning the scans revealed the baseline function of the brain and how it communicates with itself when not working on a task.

Looking at the resting state shows how the brain is working and which parts are communicating, says Darby Saxbe at the University of Southern California. The large sample size "gives us a lot of confidence that these aren't just chance associations", she says.

Results were similar in male and female individuals. This implies the greater connectivity isn't because of pregnancy, say, but rather to do with caregiving, suggest the researchers. The demands of childcare or running a household may be behind it. Parents might also be more social and physically active, factors already known to help the brain's resilience to age-related decline. ▮

Mathematics

Game theory shows we never learn perfectly from mistakes

Karmela Padavic-Callaghan

SPENCER PLATT/GETTY IMAGES

When people trade stocks, they don't always learn from experience

HOWEVER much we learn from things going wrong, we will never become optimal decision-makers. This finding comes from a mathematical game that simulates a large economy, and suggests we may need to rethink assumptions built into economic theories.

In such theories, people are typically represented as rational agents who learn from past experiences to optimise their performance, eventually reaching a stable state in which they know how to maximise their earnings. This assumption surprised Jérôme Garnier-Brun at École Polytechnique in France because, as a physicist, he knew that interactions in nature – such as those between atoms – often result in chaos rather than stability.

To test whether economists are correct to assume that learning from the past can help people avoid chaos, Garnier-Brun and his colleagues devised a mathematical model for a game featuring hundreds of simulated players. Each player can choose between two actions, like buying or selling a stock. They also interact with each other, and the players' decision-making is influenced by what they have done before – meaning they are able to learn from experience.

The researchers could adjust the precise extent to which a player's past experiences influenced their subsequent decision-making. They could also control the interactions between the players to make them either cooperate or compete with each other more.

"In some scenarios, the researchers expected that the game would always result in chaos"

With all these control knobs available to them, Garnier-Brun and his colleagues used methods from statistical physics to simulate different game scenarios on a computer. In some scenarios, the researchers expected that the game would always result in chaos, with players unable to learn how to optimise their performance. Economic theory would also suggest that, given the right set of parameters, the players would settle into a stable state where they had mastered the game – but the researchers found this wasn't really the case. The most likely outcome was a state that never settled (*Physical Review X*, in press).

Team member Jean-Philippe Bouchaud, also at École Polytechnique, says that, in the absence of one centralised, omniscient, god-like player who could coordinate everyone, regular players could only learn how to reach "satisficing" states. That is a level that satisfied minimum expectations but not much more. Players gained more than they would have done by playing at random, so learning wasn't useless, but they still gained less than they would have if past experience had allowed them to truly optimise their performance.

Bouchaud says the game model is too simple to be immediately adopted for making real-world predictions, but he sees the study as a challenge to economists to drop many assumptions that currently go into theorising processes, like merchants choosing suppliers or banks setting interest rates.

The finding could also be important for simulating processes like foraging decisions by animals or for some machine-learning applications, says Tobias Galla at the Institute for Cross-Disciplinary Physics and Complex Systems in Spain. ▮

Analysis Gene editing

Can genetically modifying a rare marsupial save it?

Researchers are aiming to make the northern quoll resistant to the toxic cane toads wiping it out in Australia, reports **Michael Le Page**

THE US-based "de-extinction" company Colossal Biosciences claims a team it funds in Australia has taken "a major step" towards saving an endangered marsupial called the northern quoll.

The plan is to genetically modify the animals to make them resistant to the toxin of the cane toad, but so far the team has only edited the cells of another marsupial.

The northern quoll (*Dasyurus hallucatus*) is a small, mostly carnivorous marsupial found in northern regions of Australia.

Populations have been devastated by introduced predators such as cats and the loss of habitat. But the biggest threat is the invasive cane toad (*Rhinella marina*), which secretes a toxin that kills many would-be predators in Australia.

This works by inhibiting a protein that pumps sodium out of cells, which means sodium levels can rise to dangerous levels. Outside Australia, changes in the pump protein that confer resistance have evolved in species from insects to hedgehogs.

Stephen Frankenberg at the University of Melbourne, Australia, and his colleagues want to edit the genome of the northern quoll to make it resistant too.

"Our toxin-resistance edit only changes a couple of DNA bases, which would probably arise by natural spontaneous mutation eventually anyway if quolls were to live with toads for the next few thousand years," says Frankenberg. "We're just speeding up the process so they don't go extinct before resistance can evolve naturally."

Engineering northern quolls could help save them, says Jonathan Webb at the University of Technology Sydney, Australia, who isn't part of the team.

"If the genetically engineered quolls had sufficient toxin resistance, then they would have a high chance of surviving a predatory attack on a cane toad," says Webb. "They'd either learn to avoid toads, or they might exploit the toads as food, which could help turn the tide on cane toads."

DE AGOSTINI VIA GETTY IMAGES

Northern quolls are poisoned by eating cane toads

Other approaches have failed, says Webb. For instance, his team tried to develop baits that would teach northern quolls to avoid cane toads, but this didn't prove feasible on a large scale.

Yet not much progress has been made towards genetically modifying the quolls. In 2020,

45×

Leap in resistance to cane toad toxin in edited cells

Frankenberg said that the team had used CRISPR gene editing to introduce toxin resistance into cells growing in a dish. These were from another marsupial known as the dunnart. It is in the same family as quolls, but is easier to work with.

Now, the team is about to release a study showing that the edited dunnart cells are 45 times as resistant to cane toad toxin as unaltered ones.

However, the real challenge isn't editing cells in a dish. To genetically modify mammals, scientists must extract and manipulate egg cells, and then implant embryos in females.

This is easy to do in well-studied animals such as mice, but often fails in other species. Getting it to work can take a lot of individuals to practise on. That is especially difficult with endangered species.

A major issue is that marsupial eggs develop a hard shell soon after fertilisation that prevents the injection of things such as CRISPR gene-editing machinery.

Even if Frankenberg succeeds in engineering toxin-resistant quolls, his team will still need to generate large enough numbers to release into the wild to spread the resistance gene.

"I like the idea and think it is worth exploring," says Merlin Crossley at the University of New South Wales in Sydney. But the hard part is still to come, he says. ▮

Health

Superfit runners live for longer than expected

Chen Ly

MEN who can run a mile in less than 4 minutes generally live several years longer than would be expected. This is surprising because even though regular exercise is important for heart health, too much strenuous activity has been linked to harmful cardiac outcomes.

"During really intensive or prolonged bouts of endurance exercise like running or cycling, some proteins are released that suggest injury may have happened to the heart," says Stephen Foulkes at the University of Alberta in Canada.

To learn more, Foulkes and his colleagues looked at the lifespans of the first 200 athletes ever recorded running a mile (1.6 kilometres) in less than 4 minutes.

The athletes were all men born between 1928 and 1955. They included British athlete Roger Bannister, the first person to be recorded running a sub-4-minute mile, 70 years ago this month.

Sixty of the runners had died by December 2023, with an average lifespan of 73. The surviving runners were 77 years old, on average. When accounting for where and when athletes were born, the team calculated that the sub-4-minute milers outlived the general population by 4.7 years on average (*British Journal of Sports Medicine*, doi.org/mvr2).

"These athletes build such a high-capacity system in their hearts, lungs, blood vessels, muscles and immune systems that it may be that they can recover really well from the normal stresses of day-to-day life," says Foulkes.

But Thijs Eijsvogels at Radboud University in the Netherlands says focusing on superfit people alone doesn't really challenge the idea that long-term, high-intensity exercise can have negative effects.

People with less extreme exercise regimens may have different or even better outcomes, he says. ▮

Energy

Renewables hit a record high

Clean energy generated 30 per cent of global electricity for the first time last year

Madeleine Cuff

A RECORD share of global electricity was generated by renewable energy sources in 2023 thanks to the rapid growth of solar and wind power. The year marked a turning point in the transition to low-carbon energy, according to think tank Ember, with coal and gas power on the cusp of a long-term decline.

Green electricity jumped from 29.4 per cent of total generation in 2022 to 30.3 per cent last year, a new high. This was driven by the rapid rollout of wind and solar power, particularly in China. Hydropower and other renewables, such as bioenergy, made up the remainder of this portion of generation.

Solar power is by far the fastest-growing electricity source, increasing its contribution from 4.6 per cent in 2022 to 5.5 per cent in 2023. That is the continuation of

NATURALSTRING/SHUTTERSTOCK

China has massively boosted its wind and solar energy capacity

a long-running trend; since 2000, wind and solar power have gone from generating just 0.2 per cent of global electricity to a record 13.4 per cent today.

The share generated by fossil fuels fell from 61.4 per cent in 2022 to 60.6 per cent in 2023, but the amount of electricity produced by these fuels actually rose slightly because of a 2.2 per cent hike in overall demand, mostly in China. Nuclear provided 9.1 per cent of electrical power, the same as it did in 2022.

A further surge in wind and solar deployment means that, in absolute terms, fossil fuel generation should fall in 2024 – for the first time outside economic crises or pandemics – even as demand for electricity grows, says Ember's Hannah Broadbent.

"We really think that 2023 was a major turning point in the history of energy," she says. "Not only did renewables reach this historic milestone, we also believe that it will be the peak of fossil generation as well. We expect from this year that fossil generation will start to decline at a global level."

Fossil fuel generation would have gone down in absolute terms in 2023, says Broadbent, but severe droughts in China, India, Vietnam and Mexico curtailed hydropower. Coal plants stepped in to fill the gap, leading to a 1 per cent increase in power sector emissions.

Assuming a partial return to normality for hydropower in 2024, Ember says it expects emissions from electricity generation to fall by 4 per cent in 2024, the start of a long-term decline for fossil fuels in the mix.

However, green electricity deployment must increase even more rapidly over the coming years to meet the world's climate goals. Models suggest wind and solar must deliver 40 per cent of global electricity generation by the end of the decade, around triple their current contribution, in order to meet the target of stopping global warming exceeding 1.5°C this century. ▮

"We really think that 2023 was a major turning point in the history of energy"

Technology

Nearly indestructible robot hand is being used to train AIs

IT MIGHT look awkward, but the robotic hand pictured here has extremely fast and flexible finger movements, and it is tough enough to survive intense violence. That durability is being utilised by Google DeepMind for its trial-and-error learning experiments with artificial intelligence robotics.

The Shadow Hand, developed in conjunction with Google DeepMind by the UK-based Shadow Robot Company, can go from fully open to closed within half a second and perform a fingertip pinch with up to 10 newtons of force. It can also withstand repeated punishment, such as pistons punching the fingers or a person trying to smash the device with a hammer.

This sturdiness is because "any interaction with the world is a collision damage risk", said Rich Walker, director of the Shadow Robot Company, during a press conference.

The robust design is well suited to AI-powered robotics experiments based on reinforcement learning, in which robots gradually work out how to interact with environments by fumbling through tasks via trial and error, says Ram Ramamoorthy at the University of Edinburgh in the UK. This is because during the course of such learning, many accidents tend to happen.

The Shadow Hand's chunky, three-fingered set-up weighs 4.1 kilograms in total and 1.2 kilograms per finger. Its structure means the hand looks less anthropomorphic than some

SHADOW ROBOT COMPANY

The bulky, robotic Shadow Hand is capable of deft and dexterous movements

robotic limbs, but it is highly versatile: extra fingers can be added if needed, and each finger is a modular component that can be swapped out for a replacement in case of damage.

The fingers have hundreds of sensors on the fingertips and dozens on their other segments. Tiny cameras focus on the inside surface of each finger's silicone skin – touching an object may deform the skin, so this interior view can indicate the object's hardness and shape.

"It's excellent in terms of sensing, and it's super robust," says Ingmar Posner at the University of Oxford.

The hand is also likely to be expensive – the Shadow Robot Company hasn't yet announced how much it will cost – so researchers may prefer cheaper robotic hand options even if they lack some of the Shadow Hand's sophisticated sensing and object-handling capabilities, says Posner. ▮

Jeremy Hsu

Health

Painful menstrual periods linked to worse exam results

Elizabeth Hlavinka

TEENAGE girls who have heavy, prolonged or painful periods may be more likely to receive lower scores in exams than those with lighter periods.

Gemma Sawyer at the University of Bristol, UK, and her colleagues looked at more than 2600 girls aged between 13 and 16 who took part in the Avon Longitudinal Study of Parents and Children. No trans boys were included in the research. The girls were asked whether they experienced heavy or prolonged periods and moderate or severe menstrual pain at four points over three years.

The team then compared the responses to the rate at which the girls were absent from school and their grades in GCSE exams, which are taken in England, Wales and Northern Ireland.

After controlling for factors such as body mass index and ethnicity, the researchers found that those who reported heavy or prolonged bleeding missed an extra 1.7 days of school per year than those without these symptoms.

They also scored 5.7 fewer marks on average in each of their GCSEs – the equivalent of going down a grade on the former, letter-based system, for example from an A to a B – and were 27 per cent less likely to achieve five standard passes, defined as scoring C or above.

The girls who reported moderate or severe menstrual pain missed 1.2 days more of school per year than those with little or no discomfort. They also scored 3.14 fewer marks on average in each GCSE and were 16 per cent less likely to obtain five standard passes (medRxiv, doi.org/mvqh).

Women's health has long been considered a neglected area of research. The situation is even worse with adolescent populations, says Noor Zwayne at the University of Texas at Austin. ▮

Animal intelligence

Sperm whale clicks are closest thing to human language yet found

Clare Wilson

THE calls that sperm whales make underwater are more complex than we thought – and could be the closest thing to human language yet discovered.

This claim is based on an analysis of thousands of calls made by east Caribbean sperm whales (*Physeter macrocephalus*).

"It's really extraordinary to see the possibility of another species on this planet having the capacity for communication," says Daniela Rus at the Massachusetts Institute of Technology.

Sperm whales have complex social lives, with females and their young living in small groups. They hunt their prey – mainly squid – using echolocation that involves streams of regular clicks.

Whales often vocalise at each other with short bursts of irregular clicks lasting a few seconds. "They dive together, they eat together, they hunt together," says Rus. "There is so much collaboration, and we hear their vocalisations while they do all these activities, so the question is, what does all this stuff mean?"

Sperm whales seem to communicate with sequences of clicks

AMANDA COTTON

To investigate, Rus and her team analysed nearly 9000 sperm whale calls recorded as part of a monitoring project between 2014 and 2018.

9000

Nearly this many whale calls were recorded and analysed

It was thought that this group of whales used 21 different click patterns, known as codas. The team found that there are really 18 basic codas, but they can be changed to give further levels of complexity. For instance, sometimes a coda would have an extra click tagged on at the start or end – this often seemed to indicate that it was the listening whale's turn to speak.

Another discovery is that sometimes known codas are stretched out by slowing them down while maintaining their rhythmic pattern.

Based on these findings, the researchers estimate there are several hundred possible click patterns, although only 156 were seen in this dataset. They have made a sperm whale "phonetic alphabet" to help them classify future recordings (*Nature Communications*, doi.org/mvnt).

The whales also seem to be adding complexity by combining codas in sequences, in the same way that human language involves using different letters to make words.

"Once you have this combinatorial basis, it allows you to take a finite set of symbols [and] compose them to create an infinite number of symbols," says team member Pratyusha Sharma, also at MIT.

The fact that sperm whales use the sounds for echolocation while hunting suggests they can perceive small changes in the intervals between clicks, says Paul White at the University of Southampton, UK.

"It's always been a mystery how sperm whales, which have quite complex social structures, communicate with each other when their signals are boring sets of pulses," he says. "This idea that it's the fine structure within the codas that's conveying the information is an interesting concept."

If combinations of clicks do convey a wide range of meanings, the sperm whales' communication abilities would be unique among non-human animals. Some species, including various primates, signal to each other with calls or movements, but these communication systems are too limited to be classed as language. ▮

For more on the sounds of nature, see page 36

Zoology

Longest-living cat breeds revealed

IF CATS really did have nine lives, they would be around for a very long time. To assess cat life expectancy, Dan O'Neill at the UK's Royal Veterinary College and his colleagues have analysed data on almost 8000 cats that died between 2019 and 2021, taken from vets in the UK.

Overall, cat life expectancy was just over 11.7 years. Female cats outlived males, with an expected lifespan of 12.5 years compared with 11.2 years. Crossbred cats tended to live longer (11.9 years) than purebreds (10.4 years).

Topping the longevity list are Birman and Burmese cats, both with life expectancies of 14.4 years. At the bottom are Bengal cats and sphynxes, with life expectancies of 8.5 and 6.7 years respectively (*Journal of Feline Medicine and Surgery*, doi.org/mvn8). **Chen Ly**

VADIM SADOVSKI/SHUTTERSTOCK

Really brief

HINDUSTAN TIMES VIA GETTY IMAGES

Another monthly temperature record

Global temperatures last month, which included a heatwave in New Delhi, India (pictured above), were the highest ever recorded for April. This makes it the 11th month in a row to set a record, according to the European Union's Copernicus Climate Change Service. The average global surface air temperature was 15.03°C (59.05°F).

Toad hallucinogen may have benefits

A psychedelic compound emitted by the Colorado river toad (*Incilius alvarius*) may reduce symptoms of anxiety and depression in a similar way to LSD and psilocybin, according to a study in mice (*Nature*, doi.org/mvn4). The compound is related to the drug DMT, or dimethyltryptamine.

Ultrasonic waves brew cold coffee

There is a fast way to brew a cold shot of coffee – by bombarding the coffee grounds with ultrasonic waves. The resulting drink can be ready in less than 3 minutes. Making cold brew coffee – by steeping grounds in cold water – usually takes up to 24 hours (*Ultrasonics Sonochemistry*, doi.org/mvn5).

Technology

DeepMind AI predicts how drugs interact

AN ARTIFICIAL intelligence system can now determine how proteins interact with other proteins, drug molecules or DNA.

Google DeepMind's AlphaFold AI could already accurately predict protein structure from amino acid sequences, solving one of the biggest challenges in biology. The latest version, AlphaFold 3, is able to model how proteins, including antibodies, interact with each other, as well as with other biomolecules such as DNA and RNA strands. DeepMind says the accuracy of its predictions is at least 50 per cent higher than existing methods (*Nature*, doi.org/gttgxm).

Biochemists and pharmaceutical researchers say the tool has the potential to vastly speed up their work, such as helping to discover new drugs. **Matthew Sparkes**

Space

Mars blasts plasma out of its atmosphere into space

THE Red Planet seems to be firing material out of its atmosphere, much as the sun launches explosive coronal mass ejections.

When the magnetic fields in ionised gas, called plasma, around a star like our sun suddenly change direction or snap in two, there can be a burst of energy that launches a parcel of plasma into space, known as a coronal mass ejection.

Astronomers have observed similar conditions in Mars's plasma-filled upper atmosphere, the ionosphere, even though the planet has only pockets of magnetic field produced in its crust, rather than a global magnetic field like the sun. However, mass ejections from Mars had never been spotted.

Now, Lou-Chuang Lee at the Institute of Earth Sciences in Taiwan and his colleagues have seen three explosive ejections from Mars's ionosphere using data from NASA's Mars Atmosphere and Volatile Evolution satellite. They occurred in 2014, 2016 and 2019.

Unlike mass ejections from the sun, which are dense enough to reflect sunlight and so be seen from Earth, Mars's ejections are harder to catch sight of, so the researchers instead looked for areas in the ionosphere where plasma seemed absent, called density cavities (*Nature Astronomy*, doi.org/mvn6).

Lee and his colleagues think Mars's mass ejections are caused by interactions between its lumpy magnetic field and the solar wind, a constant stream of charged particles. The stream makes the planet's magnetic field lines snap and blast out plasma.

If this is happening on Mars, it could also be occurring on other planets without global magnetic fields, such as Venus. Alex Wilkins

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Views

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Comment

Writing for the future

A new literary prize aims to reward the best climate fiction, because books can change the narrative on global warming, says **Tori Tsui**

WHEN was the last time you read a novel that was as realistic about the climate crisis as it was inspiring?

This sort of fiction is precious, especially in a world already characterised by seemingly endless chaos and disaster, and filled with doomsday-esque rhetoric and projections for the future. I have even fallen prey to these tropes in my own writing, which I know can be a disservice to what we need in times of change. Given this, as readers, we might believe that examples of measured climate fiction are few and far between and that the literary landscape only celebrates dystopia.

But all hope is not lost. As an antidote to this, a brand new literary award has been created. The Climate Fiction prize, which I will be helping to judge, aims to shine a light on the bold, exciting, nuanced, timely climate storytelling we know is out there.

The prize, which will be launched next month at the Hay Festival in the UK, will place an emphasis on the quality and originality of narrative and writing. Its organisers hope to usher in a new era of climate fiction without the need for tokenism – where "eco" is a throwaway mention. As a judge, I am interested in coming across fresh ways of exploring what the climate crisis means for us all – which doesn't mean the stories have to bang on about the science, or scare or guilt-trip us.

SIMONE ROTELLA

But why climate fiction and what purpose does it serve? As a society living through a period of deep transformation, we need literary work that is a reflection of these times, from the sheer terror of what we are already witnessing and what this means for us to the change already under way in real life – on the streets, in the courts and with organisations creating the sustainable food, energy and housing of the future. Climate fiction is an opportunity to reveal the people coming together to effect change through action, whose stories aren't yet told. Like the fungal networks that connect plants underground, they are often invisible, but, crucially, they create systems of support.

Climate fiction can also galvanise us by tapping into our emotions rather than simply providing pure, rational facts, and it can help us to visualise and explore a future we want and deserve. In essence, climate storytelling can both instigate and reflect a radical shift in the way we think and act on climate change, reaching new audiences outside the environmental echo chamber who can take action in novel and exciting ways. I am thinking here of books like Barbara Kingsolver's *Flight Behaviour*, with its unexpected hero in the rural US, or *The High House* by Jessie Greengrass, where protagonists face an uncertain climate future and try to protect their families.

But how do we encourage more people to read climate fiction and more writers to rise to the occasion? Climate Spring, a company of climate and TV and film experts aiming to change the narrative on the climate crisis, is funding the first year of the new prize and is also working with a growing number of novelists to adapt their books for the screen. It recently backed the television thriller *After the Flood*, a UK police drama set in a Yorkshire village grappling with the consequences of climate impact. It also funded and executive produced the short satire *More Flames*, which stars Phoebe Dynevor and Bella Ramsey and explores this moment when our culture isn't just reflecting the anxiety and impacts we feel, but is also wanting to pivot to showing a route out of the crisis.

We are all living in a time of great change, and today's literary works need to reflect that, from hope to despair and everything in between. With this new prize, we have the potential to celebrate diverse climate storytelling, gather momentum and remodel society for the better.

Tori Tsui is author of *It's Not Just You*. The Climate Fiction prize will launch at the Hay Festival on 2 June

This changes everything

A scientific way to control minds

The US has been honing its psychological warfare skills since the 19th century, when it started sending anthropologists onto battlefields, says **Annalee Newitz**

Annalee Newitz is a science journalist and author. Their latest book is *Stories Are Weapons: Psychological warfare and the American mind*, which is out in June. They are the co-host of the Hugo-winning podcast *Our Opinions Are Correct*. You can follow them @annaleen and their website is techsploitation.com

Annalee's week

What I'm reading
Victor Manibo's delightfully evil novel Escape Velocity, *which is basically* Knives Out *in space.*

What I'm watching
The Fallout *TV series, which is a disgusting and hilarious satire of US propaganda in a nuclear post-apocalypse.*

What I'm working on
A novella about robots who make noodles.

This column appears monthly

I HAVE a new book coming out in June, and *New Scientist* is to blame. Back in the summer of 2020, I wrote this column about a study led by computational social scientist Meysam Alizadeh, who worked to algorithmically predict waves of propaganda on Twitter and Reddit. Alizadeh said he and his colleagues wanted to create a "propaganda weather report" so that people on social media would be forewarned about incoming influence campaigns. It seemed like a great idea.

As we talked, I told Alizadeh about a complex psychological operations (psy ops) campaign I had witnessed on Twitter – a likely Russian effort to sow chaos around Black Lives Matter protests in Washington DC. Something in my tone must have tipped him off that I was obsessed. "You should write a book about this," he said. I laughed and demurred that writing about psy ops was way too depressing and not very scientific.

Four years later, I have a book in my hands called *Stories Are Weapons: Psychological warfare and the American mind*. It is a deep dive into psychological warfare campaigns waged by the US government, starting in the late 18th century with a fake newspaper produced by Benjamin Franklin, full of lies about British war crimes during the American Revolution. I follow the thread to the present-day US, looking at online propaganda and culture wars. I spoke with a lot of people like Alizadeh who are trying to stop psychological warfare and rebuild the public sphere. Some use technology, but others are doing it by preserving history in independent archives, or telling new kinds of stories.

I was right that the book would be depressing to research, but I was wrong about the science. In the US, psy ops grew out of the military's efforts to control the minds of its enemies as efficiently as possible, using cutting-edge science. This isn't unusual – many countries have taken a so-called rational approach to creating propaganda – but the US's unique history gave its brand of psy ops its own peculiarities.

Psychological warfare became a professional branch of the military during the first world war, but the US government honed its psy ops skills during the 19th century, when it was at war with hundreds of Indigenous nations and confederated tribes.

"Operatives would study their targets' cultures and ideals, then use what they had learned to destabilise them"

Often, the War Department deployed anthropologists alongside its troops, tasking them with recording the languages and traditions of communities while the military destroyed them.

Visiting an Indigenous archive at the University of Oregon in Eugene, I pored over notebooks kept by wartime anthropologists who vainly attempted to answer lists of questions provided by the government. What is the word for "God" in the Coos language? What is the tribe's origin story? They would often give up, writing that they couldn't make their questions understood. Sometimes they would ignore the questions and fill their books with stories from the people they interviewed.

One reason for these battlefield anthropologists was to understand the enemy. Another was to bolster claims that Indigenous people lacked the social values of "civilised" Americans and needed re-education. Among the papers were letters from the War Department about shipping Indigenous children to distant residential schools, where they would be forced to speak English and read the Bible. University of Oregon anthropologist Jason Younker, currently chief of the Coquille Indan Tribe, led the effort to preserve the documents and said the whole process was "absolutely psychological warfare".

It was also a template for psy ops the US government would use for decades. Operatives would study their targets' cultures and ideals, then use what they had learned to destabilise and traumatise them. In the 20th century, the military discarded anthropology and adopted psychology for this purpose. Experts taught the military how to use images and stories to arouse the emotions of their enemies, then mislead and demoralise them.

Then things got weirder. Edward Bernays, nephew of Sigmund Freud, worked with US intelligence to combine his uncle's work with public relations. Ultimately, he used his marketing acumen to help the CIA foment a coup in Guatemala in the 1950s. His work is partly why so many propaganda campaigns resemble ads – both use psychology in an attempt to change audiences' behaviour.

As the Cambridge Analytica scandal revealed in 2018, US political operatives continue to use this toolkit. Instead of sending anthropologists into war zones, they build "psychographic profiles" of people by harvesting their data from social media sites, then targeting them with ads.

US psy ops today are cobbled together out of scientific techniques and old-fashioned flimflammery. ▮

Survey

NewScientist

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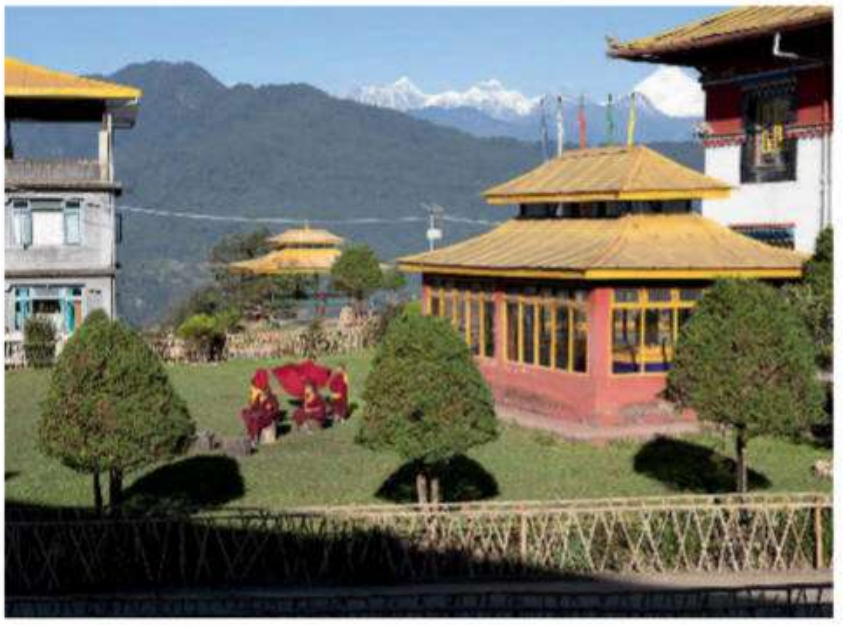

100% organic

Photographer Matilde Gattoni

IN 2016, Sikkim in India became the world's first fully organic state, with the aim of preserving the local environment, protecting its fragile ecosystems and rich biodiversity, and ensuring a healthier life for its people. All 760 square kilometres of farmland in this former independent kingdom, which is nestled between Nepal, Bhutan and Tibet, are certified organic, with a ban on importing or using chemical inputs.

Sikkim's model – based on interconnection, rather than competition, between humans and nature – could lead the way towards a more sustainable future, as climate change forces the world to redefine its agricultural priorities. According to local authorities, some early benefits of the organic revolution have been an increase in the population of bees and other wildlife and the rejuvenation of Sikkim's shallow and arid soil. The change has also led to a spike in tourism in this inaccessible land of high peaks and pristine forests, interspersed with Hindu temples, remote Buddhist monasteries and sacred lakes.

The photos show (clockwise from top left): the kitchen of a family house in Yuksom, where all vegetables grown in the garden are organic; farmers separating hulls from rice in a paddy field on the outskirts of Gangtok; Buddhist monks in the courtyard of the Tsuklakhang Royal Monastery, one of the oldest monasteries in Sikkim; an orchid greenhouse at the Hidden Forest Retreat in Gangtok; an organic field surrounding a traditional house in the village of Tingvong; and tea pickers at the government-owned Temi Tea Estate, an organic plantation.

Matteo Fagotto

Editor's pick

On the move to LEDs to illuminate our cities

4 May, p 22

From John Woodgate, Rayleigh, Essex, UK

Chanda Prescod-Weinstein laments the shift to broad-spectrum white LEDs in towns and cities because of the impact on the night sky. However, go to any sizeable theatre today and you will see from the stage lights that LEDs can be any colour. It isn't obvious why most LED road lighting is white, and it isn't certain that white is the best colour, at least for roads.

In dim light, the human eye is more sensitive to a deep green colour, and it would be perfectly possible to make green LEDs for road lighting, though people might not like them in residential areas. While we have become used to the colour rendering of sodium street lights and the earlier mercury lights, the even older gas lights were actually greenish, due to the thorium in the "mantle".

From Eric Kvaalen, Les Essarts-le-Roi, France

Prescod-Weinstein regrets that when street lighting was converted to LEDs there was no requirement that the white light be filtered to a single frequency, which would make it easier for astronomers to deal with.

But that would defeat the purpose of converting to LEDs – their efficiency. Filtering out most of the frequencies would drastically cut the amount of light produced per watt of power. Besides this, white light actually helps people to see things better at night, especially in their peripheral vision.

Plenty of progress needed to green global energy

4 May, p 8

From Christopher Jessop, Marloes, Pembrokeshire, UK

In many countries, such as India, power generation is indeed moving noticeably away from fossil fuels, with significant reductions in carbon emissions for that sector.

However, the overall energy consumption and carbon emissions of many nations is changing far more slowly, if at all, due to continued reliance on oil and gas for heating buildings and fuelling industrial processes – including plastics manufacture, as stated in another article in the same issue (p 13). And then there is transport, particularly kerosene-fuelled aviation, which is on the increase worldwide.

Are we in a cosmic hole of our own making?

20 April, p 36

From John Bell, Berkhamsted, Hertfordshire, UK

You report that we are roughly in the centre of a very rare void in the universe that doesn't match our cosmological theories. What else seems to be vanishingly rare in our part of the universe, roughly in the centre of the void? Life.

That is either an impressive coincidence or there is some cause and effect going on. Does the void make life more likely? Or maybe the seemingly unique existence of life on Earth could be generating an outward force of some sort, possibly through frequent collapse of quantum wave functions in our region, since there is more going on and more consciousness to force particular outcomes.

This would be very testable by comparing the velocities of galaxies within and adjacent to the void with those further afield to see if it continues to expand. You could then extrapolate back to see if this started when life emerged. Either way, maybe looking for voids could be a good way to understand where extraterrestrial life might exist.

From Jane Monroe, Arcata, California, US

Clearly, the reason that the Milky Way is near the centre of a cosmic void is that no other advanced life forms want to risk their worlds getting infected with Earth's planet-destroying virus. They aren't yet sure if it is catching, so they are keeping their distance.

Just so many sources of pollution to worry about

11 May, p 10

From Victoria Oswald, San Francisco, California, US

Thank you for the article on indoor climbing walls and the concerns about inhaling chemicals in the rubber dust released by the shoes used in such facilities. It was excellent, and this is something I have worried about for a while.

In a similar vein, I also have concerns about possible pollution from the rubber that can be found in artificial turf used for playing fields and in gardens, where its use has become more popular because it is touted as low-maintenance and better for the environment because it uses less water.

Demonising plastic really isn't helpful

27 April, p 36

From Rich Martin, Melbourne, Australia

The statement that "plastic, rightly demonised as a scourge of the modern world, could be fantastic again" seems to go too far in its criticism of the material.

It takes less energy to make a plastic bottle than a glass one. Additionally, plastic films play a crucial role in extending the shelf life of perishable foods, thus reducing food waste, which is a significant contributor to environmental degradation.

While advocating for increased plastic recycling and waste reduction is commendable, I urge against the oversimplification of this issue or resorting to sensationalist language. Demonising plastics does little to foster constructive dialogue or promote sustainable solutions.

Deluges could bring a climate change gain

27 April, p 16

From Geoff Harding, Sydney, Australia

The increasing frequency of heavy rainfall events in the United Arab Emirates – like the one we saw recently, probably driven to some extent by rapid climate change – may reduce dependence on energy-intensive desalination, which is currently a key source of drinking water in the region.

Interconnected underground tanks could possibly store runoff in the cities, greatly reducing the problem of flooding, and with filtration and purification, become an intermittent source of drinking water at low energy cost.

Damned if you do, damned if you don't

27 April, p 40

From Dudley Miles, London, UK

If you eat meat, researcher Anthony Hulbert recommends you have grass-fed beef or lamb and wild-caught fish, as they are high in omega-3s, and avoid pork and chicken because they are high in omega-6s. I rarely eat fish as I don't want to contribute to the destruction of aquatic wildlife, and I avoid beef and lamb – due to their larger carbon footprints – in favour of pork and chicken. It seems that you can eat to help the planet or eat to help your health, but not both. ▮

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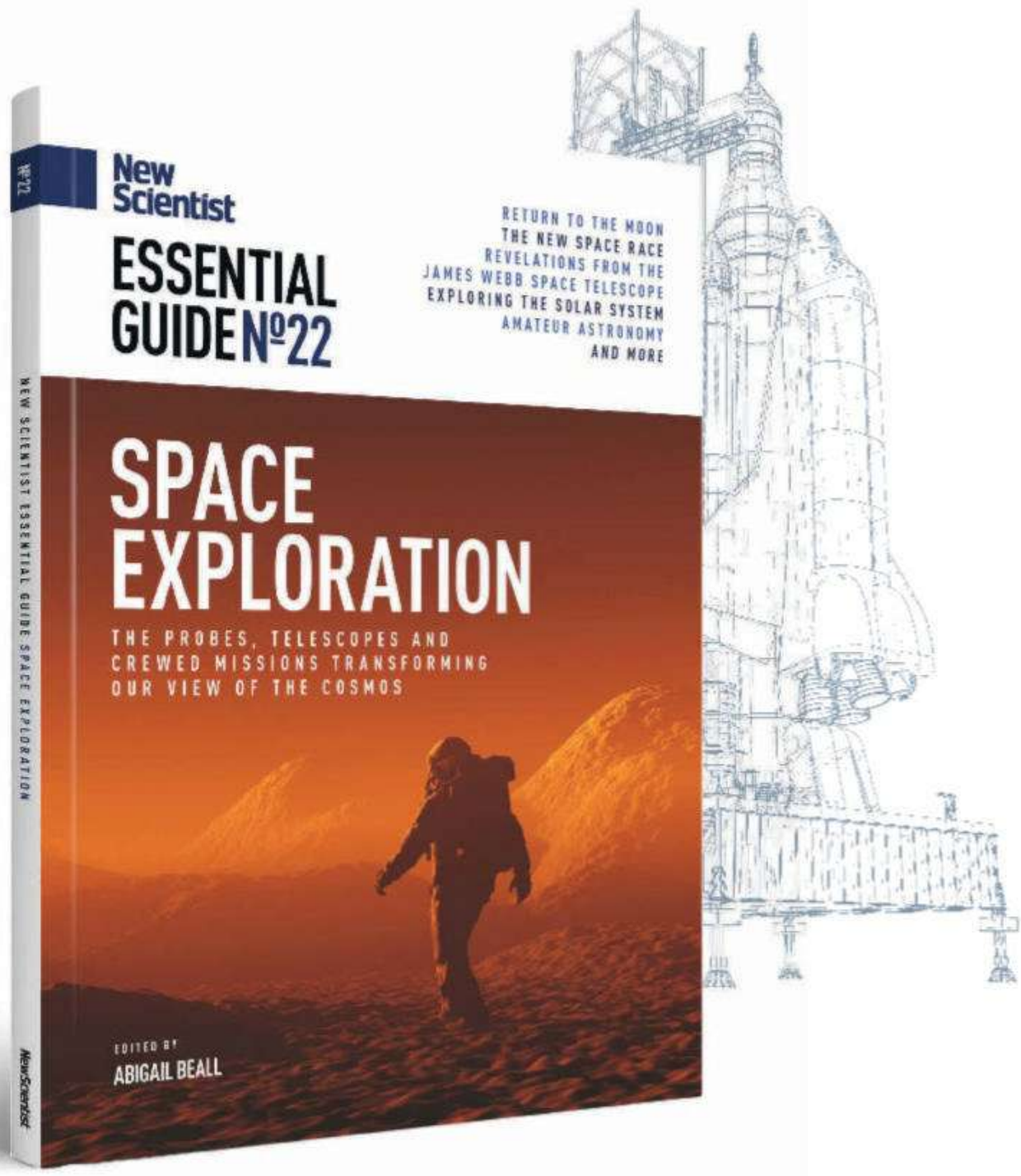
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Forces of nature

Turning data from two dramatic storms into music is the ambitious project of a man whose cancer diagnosis added urgency to the work, says **Graeme Green**

Music
Chimet
Mining
The Leaf Label

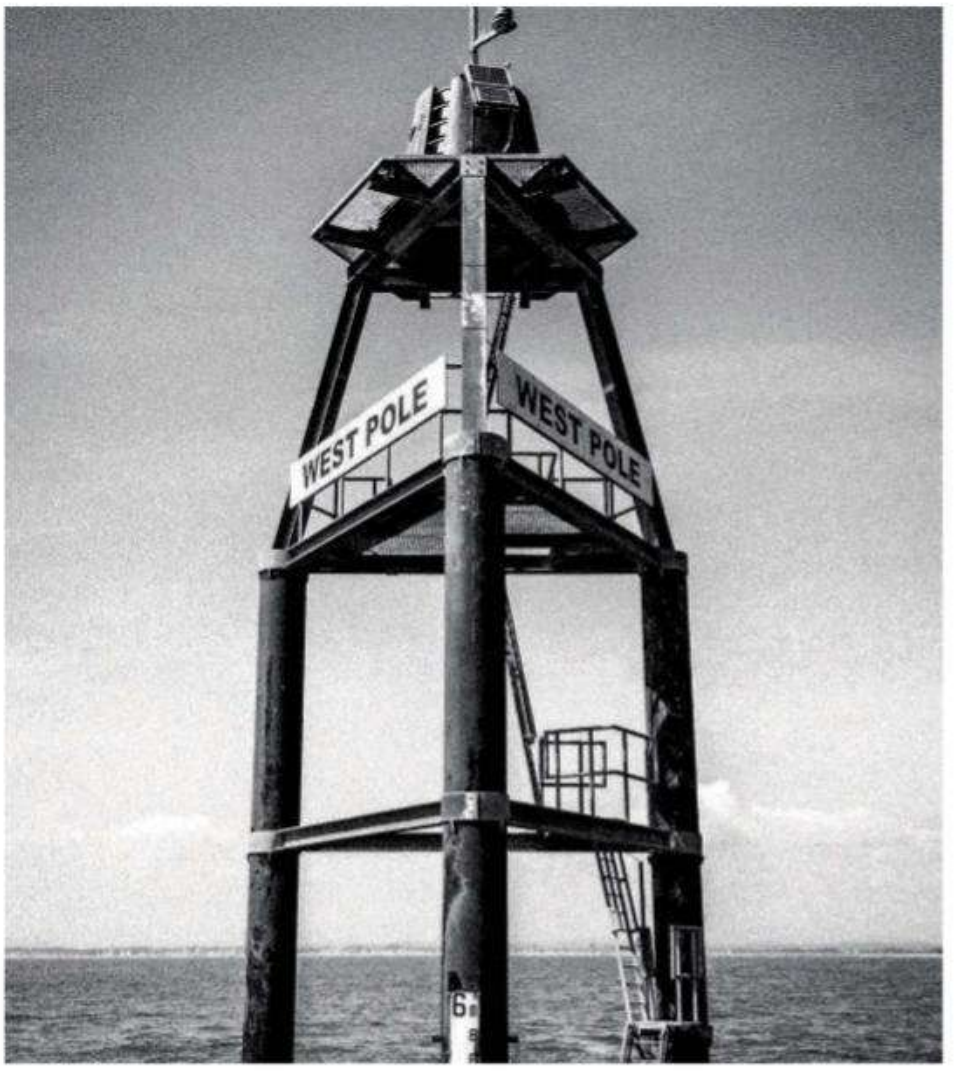
EVERY time Craig Kirkpatrick-Whitby speaks, he has to hold down a button on a device in his neck, which stops air coming out of a hole in his throat. He explains the opening-closing mechanism before he reinserts the white plastic disc. It is a heat and moisture exchanger, implanted to allow him to retain moisture in his lungs.

"I've had cancer three times in the last four-and-a-half years," he says, his voice now generated by a tracheoesophageal voice prosthesis embedded in the back wall of his neck. "I have no voice box, no lymph glands, no thyroid glands. They rebuilt my face using skin and tissue from my left leg. I couldn't speak at all for more than two years," he says. "But I don't want to be defined by my cancer. I want to do interesting stuff."

That "interesting stuff" includes innovative music, drawing on science. An investor, data scientist, sailor, ex-boxer, photographer and musician, Kirkpatrick-Whitby is the creative, curious mind driving *Chimet*, the first album by the musical collective Mining.

The instrumental pieces were built around more than 2000 sampled data streams from West Pole Beacon, known as Chimet, a navigation marker off the coast of Chichester in West Sussex, UK, that records meteorological and nautical information.

The data was captured over seven days in October 2017, as Hurricane Ophelia and Storm Brian lashed the country. Each 2-second period of music represents a 5-minute snapshot of data, including wind speed and direction, atmospheric temperature, water temperature and wave height.



PJ DAVY

The West Pole Beacon off the UK's south coast records weather and sea data

In 2016, Kirkpatrick-Whitby and sound designer PJ Davy, another member of the Mining collective, developed a "sound engine" using Max software, where algorithms organise the mined data samples into streams, which then create outgoing signals that trigger the desired intensity, notation and rhythms of a sound palette to generate music.

"I'm an investment banker," says Kirkpatrick-Whitby. "That's where my knowledge of data comes from. I live in West Sussex, about 5 nautical miles away from Chimet. I'd been coming down to this area of the south coast for sailing and windsurfing every weekend since the 1970s, which is where I saw Chimet. I've been interested in electronic music all my life and I'd been tracking storms and capturing data. When I looked at the charts from Chimet, it was very obvious to me that it looked like music."

Musician Matthew Bourne, the third member of Mining, later improvised piano over the atmospheric soundscape, with a cello and a Memorymoog synthesiser added for texture. *Chimet* doesn't contain direct audio recordings, but is more an evocation of a storm, a meditative, eerie music of drones, pulses and clicks reminiscent of the *Blade Runner* soundtracks or Brian Eno's ambient work.

"There is the 'Mother Nature'-orchestrated music and the 'human nature' [orchestrated music], which reinforces the feelings of the storms," explains Kirkpatrick-Whitby. "We wanted to create an experience that evoked the feelings of being on the water or the beach, and being in the weather."

As well as terrifyingly strong winds, Hurricane Ophelia and Storm Brian also brought dust storms and widespread damage. But Kirkpatrick-Whitby enjoys a good storm. As someone who says he is very sensitive to music and weather, he suggests that he may experience it through his body more than other people do. "My senses are enlivened by it. Weather is incredible," he says. "I like a storm. I love snow. I love ice. These are all things that make you feel alive and sharpen the brain."

Originally from London, Kirkpatrick-Whitby's work in global banking has taken him around the world. There has been a restless curiosity about the variety of his other pursuits, too: a one-time boxer, he now enjoys yacht racing and photography. His 6000-strong CD collection ranges from Ravi Shankar to Tangerine Dream, but it mostly consists of electronic music, including dance and what he calls "quite unusual, rare, neoclassical ambience".

Before his cancer diagnosis, he also sang in bands. "I had a very powerful voice, like Michael Stipe or Eddie Vedder," he tells me. "Losing your voice is quite astonishing."

Originally planned for release in 2019, *Chimet* was delayed by Kirkpatrick-Whitby's cancer

treatment. "I wanted to get the album out before I died," he says.

The use of data to create music isn't new, but Kirkpatrick-Whitby believes it hasn't been done on the scale of *Chimet* before, with musicians usually working with single strands of data, such as wind speed. "We've used 14 separate variables," he says. "And captured 30,000 data points."

The process can be applied to all kinds of data, from medical records to that relating to climate change. "As long as I understand

"*Chimet* is an evocation of a storm, a meditative, sometimes eerie music of drones, pulses and clicks"

the data and can format the data, I can sonify anything," reckons Kirkpatrick-Whitby. "I've got info on satellite data that I'm looking at. I'm also looking at sonifying mathematical conjectures."

He is also thinking about cancer data. "Before I lost my voice, I was on conference calls with people who run data for the National Health Service [in the UK]," he says. "I recently applied to work with my surgeon on a cancer project.

Craig Kirkpatrick-Whitby plans to return to work and make more albums

CRAIG KIRKPATRICK-WHITBY

I'll have access to data and could create music that derives from the statistics from cancer patients across the UK or data that has been professionally anonymised and is allowed to be used."

At the age of 59 and after a medical all-clear, he hopes to "exist in the normal world" again. "My attitude to life hasn't really changed. But cancer has changed other people's perceptions of me," he says. "I was a noisy, good-fun, centre-of-attention type of bloke. I was quite good-looking, reasonably wealthy. I've become more insular, more introverted.

"People pay less attention to what I have to say now because they view me as disabled. My brain is fine, but it does take effort talking," he says. "People butt in all the time. I end up feeling disappointed by social engagements because I've not been able to freely express myself in the ways I used to. I've lost a lot of acquaintances because they can't be bothered."

He plans to return to work. There will be more music, too, with plans under way to record two new albums with Mining. He is also working on his own keyboard compositions.

"I feel blessed to be alive. I was at the Royal Marsden hospital in Chelsea the other day and there was a 12-year-old girl who'd had throat cancer since she was 10 – unbelievable," he recalls. "I can still walk... I'm vocally disabled but my brain is fine. I can drive a car. I can't go near water because if I go in, I would fill up with water very quickly," he chuckles.

"This," he says, pointing at his augmented throat, "is not ideal. But I'm still alive." ▮

Graeme Green is a writer based in Derbyshire, UK

Uncreative thinking

Creativity's origins may be too complex for simple explanations, finds **Sandrine Ceurstemont**

Book

The Creative Brain

Anna Abraham

MIT Press

FLUXFACTORY/GETTY IMAGES

What is it in the brain that allows some of us to create fabulous and complex artworks?

CREATIVITY is a product of the human mind. But why are some people more creative than others, making it seem elusive or a gift?

Having a neurodivergent brain has been proposed as one possibility. Take Wolfgang Amadeus Mozart's musical creativity. It has been suggested that he had Tourette's syndrome, a brain condition linked to a range of symptoms including obsessive behaviour, which could have played a role. Other proposals link creativity to intelligence or even to the use of psychedelic drugs.

In *The Creative Brain: Myths and truths*, neuroscientist Anna Abraham examines these ideas and four more, describing them as myths and dedicating a chapter to each. But rather than fully debunk them, Abraham's premise is that they all contain a kernel of truth.

She delves into how these beliefs developed and spread – and why they are so hard to relinquish. Her focus is on how misinformation is often related to conflicting results in the scientific evidence that is supposed to back them up.

Take the common idea that the brain's right hemisphere is associated with creativity. Both behavioural and brain-based studies have explored this, but findings are hard to compare because the ways of measuring different aspects, such as the level of creativity, vary greatly. This means we can find evidence supporting both the right and left hemispheres being dominant in creative activities, as well as the joint involvement of the two.

Such problems, says Abraham, stem from the fact that creativity typically involves many elements, but the focus is often drawn to just one, the imagination needed to make something new. Other aspects – such as the drive to create, the hard work involved and the ability to produce something that resonates with an audience – are also crucial. Many explanations, she says, treat creativity too simplistically: for example, taking psychedelic drugs can make someone more open, and thus better able to think creatively, but may not affect their motivation.

Abraham provides a good overview of the relationship between creativity and the brain, covering a lot of ground while doing so. But her book would have been a lighter read if it had included more colourful anecdotes to illustrate the myths. Her penchant for posing more questions than she answers can also sometimes feel unsatisfying.

All in all, however, Abraham provokes readers to think more deeply about brain-based creativity theories, even if they seem backed up by evidence. How creativity originates in the brain is complex and probably can't be explained by a simple narrative. Perhaps we need a novel approach. ▮

Sandrine Ceurstemont is a writer based in Morocco

The TV column

A world to watch

Here's our pick of the best science documentaries of the year so far, from David Attenborough on the rise of the mammals to a profile of Victor Glover, soon to be the first Black astronaut to orbit the moon, says **Bethan Ackerley**

Bethan Ackerley is a subeditor at *New Scientist*. She loves sci-fi, sitcoms and anything spooky. She is still upset about the ending of *Game of Thrones*. Follow her on X @inkerley

BBC STUDIOS

BBC TV series *Mammals* shows why this group dominates the planet

WHEN it comes to TV criticism, three things tend to be true: documentaries don't always get the attention they deserve; when they do, they are probably about nature; and they are probably narrated by David Attenborough. I am not immune to this tendency as you will see from what follows.

There have already been many science documentaries that we haven't had a chance to cover this year. Here are some of the best.

Let's start, inevitably, with entries from the incomparable Attenborough. *Mammals*, a six-parter available on BBC iPlayer in the UK, charts the rise of this extraordinary group of animals. An impressive ability to adapt has allowed them to survive in Earth's most extreme places, but their 66-million-year reign is now threatened by the black sheep of the family: humans.

Looking back to the start of 2024, *Attenborough and the Giant Sea Monster* on BBC iPlayer (*Attenborough and the Jurassic Sea Monster* in the US, via Amazon Prime Video) transported us 150 million years into the past to the time of the pliosaurs. This special reveals how, thanks to the discovery last year of a remarkably intact skull in the cliffs of Dorset, UK, we are learning more about these enormous marine reptiles.

Two more documentaries offer a unique perspective on nature: *Earthsounds* on Apple TV+ uses immersive audio to capture the unexpected ways that animals communicate with each other, be they Puerto Rican parrots or cocktail ants. Netflix's *Our Living World*, meanwhile, is all about the connectedness of ecosystems. It does a great job of explaining how a tiny shift in one corner of our planet can cause a deadly cascade of environmental changes.

"The two-part Netflix documentary *Can I Tell You a Secret?* takes a harrowing look at cyberstalking"

Sticking with the natural world, *Secrets of the Octopus* and *Queens* are two excellent outings from Disney+. The former is a three-parter digging into the mysteries of these intelligent cephalopods, which may challenge the anthropocentric view of consciousness as a human trait. The latter, narrated by Hollywood royalty Angela Bassett, explores six species in which females rule the roost. It is a fun look at a bevy of animal matriarchies, including lions, leopards and bears (oh my!).

Leaving nature, it has been over 20 years since the space shuttle Columbia disintegrated on re-entering Earth's atmosphere, killing the seven astronauts on board. In three instalments, *The Space Shuttle That Fell to Earth* on BBC iPlayer (in the US, *Space Shuttle Columbia: The Final Flight*, via CNN) commemorates those who died and explores what went wrong on that fateful day.

NASA+, the US space agency's newish streaming service, has been updating its ad-free educational content. Among the highlights are *The Color of Space*'s profile of Victor Glover, soon to be the first Black astronaut to orbit the moon, and an episode on Europa in its *Other Worlds* series, in the run-up to the launch of a probe to this icy moon of Jupiter.

And finally, something very different in Netflix's *Can I Tell You a Secret*? Adapted from *The Guardian*'s eponymous podcast, the series is a harrowing look at cyberstalking. Matthew Hardy spent over a decade harassing women over Facebook, WhatsApp and Instagram, but his offences were often downplayed by police because they took place online. This two-parter highlights the uniquely invasive part technology can play in that abuse. A difficult watch, but enlightening. ▮

TV

Mammals
BBC iPlayer (UK only)

Attenborough and the Giant Sea Monster
BBC iPlayer (US details in main story)

Earthsounds
Apple TV+

Our Living World
Netflix

Secrets of the Octopus
Disney+

Queens
Disney+

The Space Shuttle That Fell to Earth
BBC iPlayer (US details in main story)

The Color of Space: The Series/Victor Glover
NASA+

Other Worlds: Europa
NASA+

Can I Tell You a Secret?
Netflix

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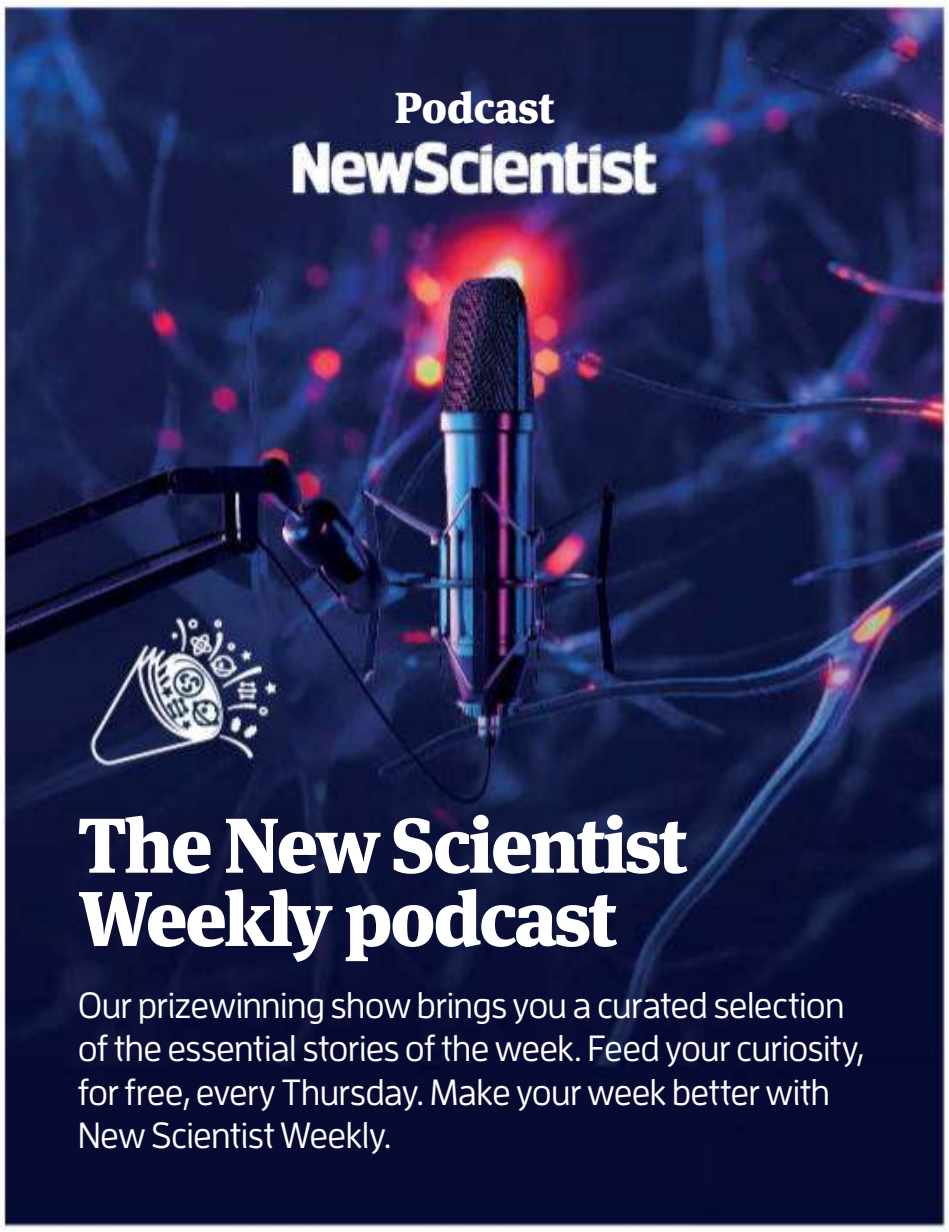

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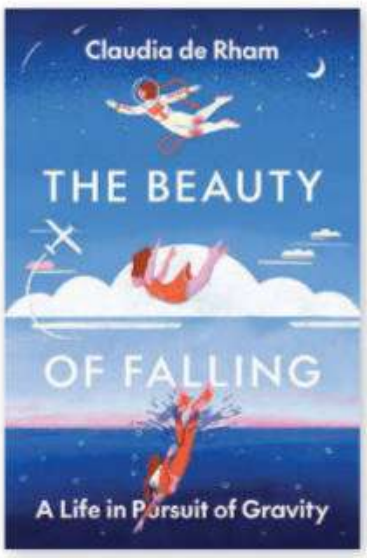
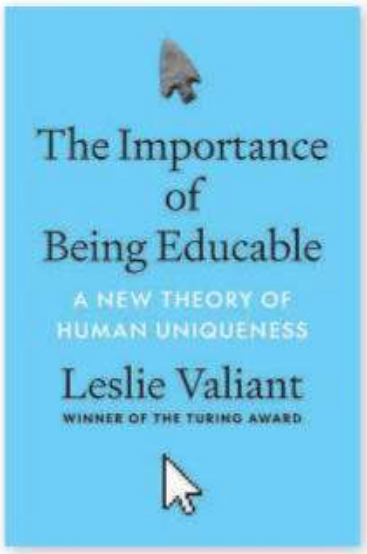
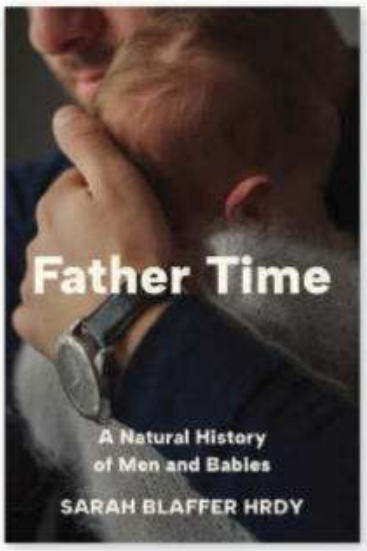


A world-renowned physicist seeks gravity's true nature and finds wisdom in embracing its force in her life



In the age of AI, why our future depends on better understanding what makes us human



A sweeping account of male nurturing, explaining how and why men are biologically transformed when they care for babies

How an iconic bird's final days exposed the reality of human-caused extinction

PRINCETON UNIVERSITY PRESS

Over the hill?

Positive attitudes towards ageing don't just benefit society, they also help you live a longer, healthier life, reports **Clem De Pressigny**

LAST Christmas, my 4-year-old was worried that Santa might forget some presents on his list – "because Santa is old". I was shocked. At that moment, I realised that he had already picked up negative stereotypes about older people. Perhaps I shouldn't have been surprised given the way they are portrayed on TV and in film, books and ads, as well as the ways that we collectively talk about ageing. But given what I now know about such views, I was deeply concerned.

Ageism is arguably the last acceptable prejudice. While other forms of discrimination are considered reprehensible, it is normalised. The World Health Organization reports that, globally, 1 in 2 people are ageist. Unfounded stereotypes about old age directly affect the lives of those in their later years – their financial opportunities and medical treatment, for example. Ageism is one of the biggest barriers faced by people everywhere, affecting all facets of life, says Nancy Morrow-Howell at Washington University in St. Louis, Missouri. "It's so pervasive, it's so accepted, it's so invisible."

But ageism isn't just bad for society. My concern about my son's developing ideas of old age also stems from the discovery that negative stereotypes of older people are bad for the individual who holds them too. Researchers have found that they affect how we age, both physically and mentally, with impacts on many aspects of our later lives, from memory function and hearing loss to the risk of depression and even how long we live. The scale of these effects can be enormous. However, knowing this also presents us with simple opportunities to change things.

As my son's comment indicated, this is a problem that starts early. Our stereotypes about older people are already mostly negative by the time we begin school. "Children learn from what they see," says Anna Kornadt at the University of Luxembourg. And they see that some people look a certain way – they have grey hair and wrinkled skin and sometimes move differently. "This is a very obvious social category that helps children understand the world," she says. That alone isn't the issue. The problem is how their culture then defines people within this simplified category and continually reinforces a bleak narrative around what it means to be old.

Prejudice comes at children from all angles – not just the media, but also the language used by their family members. For example, a parent lamenting reaching a certain age may

ROBERT CARTER

say they feel "over the hill" or some other entirely accepted trope about how awful it is to get old. Other sayings like "you can't teach an old dog new tricks" reinforce the notion, often taken as fact, that when you are old, you are incapable of learning and changing.

While racial and gender-based stereotypes are widely understood to be rooted in structural inequalities that shape the world rather than any kind of inherent attribute of

"People with positive age beliefs live an average of seven-and-a-half years longer"

a group of people, our generalisations about older people are still considered true to life. Yet, largely, they aren't. Older adults aren't a monolith of dependent, frail and forgetful people, nor are they all wise and kind. They are an extremely varied social group that requires the same nuanced consideration we know is essential to understanding any socially constructed grouping. Yes, the risk of disability and certain illnesses increases as we age. But, in fact, good cognitive ability and health remain intact for the majority of older people, right into their final years.

When Kornadt explores conceptions of old age with her undergraduate students, she begins by asking them to guess how many of them will get dementia. "A lot of them think, 'OK, if you're old, you will get dementia no matter what'," she says. "But in the end, for people over 90 years, it's only 30 per cent." And it is only 10 per cent of everyone over the age of 65. So, chances are, most people won't get dementia in their old age. It is the same with loneliness, says Kornadt. There is an assumption that when you are old, you are lonely. But she points out that young people are just as likely to experience loneliness.

Kornadt notes that negative stereotypes of older people can benefit us when we are young: they elevate us in comparison. But eventually, if we are lucky, we get old too. "Then this turns into a stereotype about the group you yourself belong to," she says. "We try to fend this off as long as we can." Kornadt says that when people are asked at what point old age starts, they continually push it to beyond their own age. ›

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It isn't until around 75 that people start to acknowledge that they are part of a group experiencing old age. This is when those negative stereotypes become how we think about ourselves, after being embedded in our thoughts decade after decade. And the consequences can be dire.

One of the first people to expose this was Becca Levy at Yale University. In 2009, she and her colleagues published a landmark paper showing that people who believed negative stereotypes about old age in their younger years had a much greater chance of having a cardiovascular event, such as a stroke or congestive heart failure, decades later. Another study led by Levy found that buying into pessimistic concepts of old age results in a 50 per cent greater chance of being hospitalised in later life compared with people who think positively about it. A third showed that those negative stereotypes were linked to being much less likely to recover from a disability from the age of 70 onwards. In 2019, research by Levy and Martin Slade, also at Yale University, even connected ageism to a greater likelihood of being obese in old age.

Then there is memory. As demonstrated by my son, it is widely assumed that being old inevitably means being forgetful. Memory is indeed affected by age: as the brain's structure changes, working memory, which holds information temporarily as we are thinking, tends to decline. But it isn't all downhill. Semantic memory, the ability to recall facts and concepts, often improves as we reach our later years. There are numerous factors at play in how sharp our memory remains, including genetics and illness. And we can add negative stereotypes about ageing to that list. Levy's research shows that they account for a whopping 30 per cent of additional decline in memory in people aged over 60.

Self-fulfilling ageism

Intriguingly, gloomy old-age stereotypes affect sensory perception too. Becoming hard of hearing is considered just a reality of reaching our later years, but again, ageing is only one of many factors that can cause it. Levy found that ageist generalisations are another noteworthy cause.

Perhaps more obviously, there is also an impact on mental health. Negative beliefs about ageing are associated with an increased risk of depression, anxiety and suicidal ideation as we age. They can affect a person's will to live and, by extension, their choices about whether or not to take life-prolonging medications. And all this adds up. "Individuals who have taken in more positive age beliefs from their culture tend to show an average survival advantage of seven-and-a-half years over those who have taken in more negative age beliefs," says Levy. That extraordinary result has been found again and again in numerous countries, including Germany, China, the US and Australia.

How exactly do negative age stereotypes have such drastic repercussions? Levy posits three pathways. One is physiological. "People who have taken in more negative age beliefs tend to have higher cortisol levels, which is the main stress biomarker, and that has been found to have adverse impacts on a number of different outcomes," she says. Indeed, numerous studies show that being exposed to negative age stereotypes, even subliminally, increases people's blood pressure and heart rate. When this happens again and again, your health can be seriously harmed.

Levy's second pathway is psychological. Once internalised, old-age stereotyping ends up becoming a self-fulfilling prophecy, shaping our thoughts about what we are capable of doing and what we see as the inevitable outcomes of reaching our later

MARK HENLEY/PANOS PICTURES

Older people with more positive views on ageing are more likely to be pysically active

VIKTOR PRAVDICA/ALAMY

Ageism starts early, but meaningful intergenerational contact helps reduce it

years. "People who take in more positive beliefs tend to have higher self-efficacy or a higher sense of mastery in different aspects of their life," says Levy. "So they're more likely to feel like they can accomplish certain goals, and that may encourage them to do better on cognitive tasks." Believing negative stereotypes has the opposite effect. It can also block the psychological resources that could allow us to act in ways that would keep us in good health for longer. It might, for instance, interfere with the sophisticated cognitive skills that can compensate for hearing loss, such as drawing on context, memory and comprehension to fill in missed bits of conversations.

Learned helplessness

Levy's third pathway is rooted in behaviour. "Those who take in more positive age beliefs tend to engage in more beneficial health behaviours, like being physically active and taking prescribed medications," she says. Conversely, ageist stereotypes can result in people behaving as if they are unable to do certain things, such as continuing to work, exercising or taking up a new hobby. It also fosters dependent behaviours. One study, for example, showed that after being exposed to ageist ideas, older people were more likely to ask for help to complete a puzzle. So an older person may stop doing things for themselves, with no physical or cognitive reason other than those beliefs.

How all this plays out differs depending on an individual's gender and culture (see "A multifaceted prejudice", above right). But with many countries now having an increasingly older population, issues like real or imagined intergenerational competition over social and economic resources could be exacerbating the problem. "I think, with time, there has been an increase in negativity of age stereotypes," says Levy. The covid-19 pandemic laid bare some of these prejudices in the way that older people were treated in the healthcare system. But systemic ageism is ingrained throughout many societies, from the media and education to housing and the workplace.

Pushing back against ageist stereotypes will require structural changes, which is difficult. But it is never too early, or too late, to change your own thinking about old age. Morrow-Howell says that unlearning internalised ageist stereotypes can take a lot of one-on-one work with someone very knowledgeable about the topic. But simply increasing awareness about ageism also goes a long way, she adds. Morrow-Howell encourages older people she works with at the National Center to Reframe Ageing in the US to understand what is really behind the belief that they are "too old" for something. Is it a health issue? Is it desire or preference? Is it because of social factors? "We just have to keep separating age as the primary driver," she says.

Levy also says that recognising and understanding our prejudices is key to dismantling them. "If you aren't aware that these negative age stereotypes are having an impact, it's hard to fight them, it's hard to challenge them and prevent their impact." In her book, *Breaking the Age Code*, she lists common beliefs about old age – including that older people can't use or invent new technology, that they should avoid exercise because they are frail, that they don't have sex – and then counters each myth with the facts.

Another way to reduce ageism is through meaningful interactions between younger and older generations, as a study that brought teenagers together with older people to share wisdom revealed. It also highlighted the need for these interactions to be based on reciprocity, not a younger person feeling like they are doing some act of charity for an older person. "It's meaningful intergenerational contact, not just meeting people but really working towards a common goal," says Kornadt. For many of us, these are rare. But there are some cultures where multiple generations are more likely to still live together, promoting positive age beliefs. This might help explain why, in the UK, Black people and those of Asian ethnicity generally outlive white people, for example.

For myself, having this knowledge has made me much more aware of the language I use when talking about age. It has made me see how ubiquitous ageism is – and I don't let these stereotypes go unchallenged. It has shifted my thinking about how much I will be able to do in the decades to come, too. And as for Santa, he didn't forget anything on my son's list. ▮

Clem De Pressigny is a freelance writer and editor

A multifaceted prejudice

It has long been thought that there is an East-West cultural divide when it comes to attitudes towards older people. This assumption is partly based on the fact that filial piety, or a deep respect for parents and grandparents, is an aspect of the ancient Chinese philosophy of Confucianism. But research doesn't always back it up. In an effort to understand why, Anna Kornadt at the University of Luxembourg and her colleagues conducted a cross-cultural study in China, the US and Germany.

Their results showed that it depends on what aspects of life are considered. Those in the US viewed older people in more positive terms when it came to health than those in Germany did, whereas Chinese people had a more positive attitude when it came to concepts around older people being good at things like solving life's biggest quandaries.

A similar approach reveals ageism to be gendered. When drilling down into various life domains, including work, finances, health, personality, friends and family life, Kornadt's research has found differences in the way that men and women experience it. One study in Germany, for example, found that as women get older, negative stereotyping around work and finances increases more than for men. But they are seen in a better light in social realms, such as friendship and leisure.

Negative stereotypes of ageing have huge effects on our physical and mental health in old age (see main story). If we are to tackle the problem, we need to understand these cultural and gendered nuances of ageism.

ONDREJ PROSICKY/ALAMY

DARRELL GULIN/GETTY IMAGES

Sounds of the forest

A sonic survey of Costa Rica's restored ecosystems could help acoustics become a widespread tool for monitoring biodiversity, discovers **James Dinneen**

GIACOMO DELGADO has lost his microphone. As we peer into the cloud forest of Costa Rica's Barva volcano, a GPS device tells him it is somewhere nearby, but the only note he left when he placed the mic here is that it is attached to a moss-covered tree. That would be helpful, except it describes nearly every tree in the old forest. He squints. "I hate it when I don't give myself good notes."

For the past two months, Delgado, a doctoral researcher at ETH Zurich in Switzerland, and two other teams from Costa Rican universities have bounded across the country recording the soundscapes of its forests. The survey involves positioning microphones at more than 600 sites in every type of forest ecosystem in Costa Rica, making it, by some measures, the largest such "ecoacoustic" survey ever.

The survey is part of a shift in the way we monitor ecosystems. Cheaper audio recorders and improved methods of analysing complex acoustic data using machine learning have led to a boom in this field. And researchers are increasingly listening in to ecosystems to hear how they change and monitor their health.

In Costa Rica, by comparing the soundscapes of regenerating forests with those of forests with their biodiversity intact, the researchers aim to take the measure of ecosystems coming back to life across the country, in what could be some of the first evidence that large-scale

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ADRIAN HEPWORTH/ALAMY

Rainforests are home to a diverse selection of animals, such as (clockwise from top left) black guans, peccaries, pit vipers, tree frogs, howler monkeys and blue morpho butterflies. Listening to the soundscape of a forest can help monitor these species and more

SHUTTERSTOCK/MARK_KOSTICH

forest restoration brings back the full diversity of ecosystems. But this has the potential to reach far beyond Costa Rica. The effort could support plans to change the way we monitor biodiversity across the entire planet.

The study of animal sounds in nature, known as bioacoustics, largely got its start underwater, where sound reaches further than light. Many marine animals leverage this quality to communicate. Likewise, researchers have long used sounds to study their lives and habitats, from tracking how songs are passed between different groups of humpback whales to documenting how a coral reef ecosystem reassembles after a hurricane.

Traditionally, researchers hoping to gauge biodiversity in terrestrial ecosystems would use old-fashioned field surveys to count species or set up automatically triggered camera traps that capture images of animals moving past. These days, an increasingly common method is to sequence the ambient environmental DNA found in air, water or soil and take a species census that way.

Now, though, bioacoustics on land is "transforming how we can monitor and understand the environment", says Paul Roe at the Queensland University of Technology in Australia, where he runs a network of more than 300 permanent acoustic sensors distributed across the continent. Some researchers use sound to track the behaviour of a particular species. A duet by endangered gibbons might reveal a hidden pair in the jungle. The rate of meerkat alarm calls has been linked to changes in vulture populations. Conservation organisations listen for gunshots or chainsaws.

Roe has used his acoustic observatory to study the ecological effects of the invasive species and bushfires that are becoming more frequent with global warming. This method, which captures the dynamics not only of individual species but also of entire ecosystems, is called ecoacoustics.

Microphones offer an affordable tool to record ecosystems across large areas, revealing subtle changes to their biodiversity. Last June, for instance, Vijay Ramesh, then at Columbia University, New York, and his colleagues studied the soundscapes of restored forests in the mountains of south-western India. They found that insects like katydids, also known as bush crickets, that make high-frequency sounds were missing even after decades of regrowth. In 2022, Zuzana Burivalova at the University of Wisconsin-Madison and her team found that tree plantations and forests used for logging in Borneo lacked the dawn and dusk chorus common to pristine forests.

Delgado's survey is looking for similar gaps, but at a much larger scale and in a country many see as a beacon of hope in the fight against biodiversity loss. At its lowest point, in the 1980s, following rapid deforestation due to cattle ranching and agriculture, only about a quarter of Costa Rica was covered in forest. But the forest started to rebound as the price of beef fell and people abandoned agricultural land. In 1996, the country introduced a programme called Payment for Environmental Services (PES), in which the government pays landowners to preserve and restore forest on their property.

Today, trees cover about 60 per cent of Costa Rica. If the survey finds this has also led to the return of biodiversity, it would be some of the first solid evidence for successful large-scale ecosystem restoration anywhere. "A country turning around the state of its nature is really unheard of," says Delgado. He wants to hear it.

By the time I catch up with Delgado at the end of March, he has already logged more than 300 kilometres on foot and thousands more by car. Two months of sleeping in bare-bones ranger stations hasn't been restful. But other than some lost data and an incident with several angry spider monkeys, the survey is going as planned. "The hardest parts of my day are when nature is unpredictable," he says. ›

New Scientist video
Hear the sounds of the rainforest at youtube.com/newscientist

JAMES DINNEEN

Giacomo Delgado (above) has walked hundreds of kilometres around Costa Rican forests like those in the Poás Volcano National Park (top right) placing microphones (right) to record the sounds of its biodiversity

Our first visit is to an area of tropical wet forest in the mountains west of Costa Rica's central valley, called the Alberto Manuel Brenes Biological Reserve. We bounce up a rutted road accompanied for the day by Randol Villalobos Vega, who administers the reserve for the University of Costa Rica. Vega explains that the strictly protected area can only be visited to conduct research. This pristine forest will serve as a baseline for what an intact ecosystem should sound like.

Cued by Delgado's GPS, we hop out of the truck to collect several microphones he placed eight days earlier at 1-kilometre intervals, far enough apart to ensure the mics wouldn't capture the same sounds. The mics are a short walk from the road, but Vega still recommends we take care because the area is known to have a "healthy" number of pit vipers.

We press into the forest, hearing the ring of a few cicadas and some intermittent birdsong, including the weird quack of a black guan and the bassoon hoot of an umbrella bird. An iridescent blue morpho butterfly flits by. Any other animals are quiet in the late morning heat. But Vega assures us that the forest can be full of sound. "At the beginning of the rainy season, the forest becomes so loud it's difficult to hear," he says. Indeed, the researchers are racing to beat the weather: the survey must be completed by May to avoid the rain, which will make it impossible to compare the soundscapes of different sites.

Other microphones are more difficult to reach, requiring a steep hike up a ridge across from the reserve's research station. A few minutes up the trail, Delgado halts as a large group of boar-like peccaries snuffle past. Other than our crashing, which surely scares silent whatever wildlife is around, the loudest sound is the whine of black flies eating our necks.

As we climb, Delgado explains what he hopes this survey will reveal. By the time he is rained out, he aims to have recorded audio at around 1200 sites, or as many as he can reach in time, capturing the equivalent of more than a decade's worth of audio data covering all the major forest types in the country. As well as providing information on how successful the reforestation has been at bringing back biodiversity, data from the survey will be uploaded to an open-source web platform used to track thousands of ecosystem restoration projects all over the world.

The platform, Restor, built by ecologist Thomas Crowther's lab, where Delgado works in Zurich, currently enables people involved in ecosystem restoration projects to tap into a sophisticated array of satellite data on forests. The acoustic data will add a direct measure of what is happening "underneath the canopy", says Delgado. The hope is that people will eventually be able to upload acoustic data of their own. This could be a step towards a global network of acoustic sensors to monitor the planet, allowing researchers to observe changes in biodiversity almost in real time.

Plantations and pastures

The several forests I visited with Delgado are just half of the story. Two other teams of researchers roam the country recording the sounds of forest fragments on ranches and farms, as well as on tree plantations and cow pastures. The moos and motors of those soundscapes will contrast with the sounds of well-protected forests. The big question is what other aspects of their biodiversity will differ as well.

One of the teams exploring these sites is made up of Justin Jiménez Céspedes at the National University of Costa Rica and Daniel Vega Cháves at the National Technical University of Costa Rica. They might not have to hike as much as Delgado to reach their sites, but working on private property comes with its own set of challenges: on one occasion, they were chased out of a forest by ranchers wielding shotguns. Fortunately, on the day I spent with them in the rural Alajuela province, a few kilometres from the border with Nicaragua, we only encountered forest owners happy to have us around.

One is Oscar Rodriguez. He seems suspicious at first, but after Céspedes explains the survey's purpose, he enthusiastically gives us a tour of his property: a 700-hectare (1700-acre) plantation of hardwood trees and patchy regenerating forest, which his family has owned for decades.

As Cháves places a mic in a small stand of trees growing in an open area, Rodriguez points out a few saplings he planted. He receives around $55 a year through the PES scheme for each hectare of land he replants with trees, and a bit more for each hectare he leaves covered in forest.

While Rodriguez is in favour of the programme, he says the money isn't enough, and he worries about people continuing to clear forest. The initiative, which is mainly funded by a tax on gasoline, has long been oversubscribed and is chronically cash-strapped. Another hope Delgado has for his survey is for it to help the programme

tap into new international sources of funding such as biodiversity credits, which offer a way for people to offset destruction in biodiversity elsewhere. To make ends meet, Rodriguez is considering building tree houses to attract tourists as his forest regrows. He is interested in getting a microphone of his own.

The full survey results won't be available for at least a year. But there are already indications that ecosystems are returning. Two years ago, as a pilot study for this larger project, Delgado carried out an acoustic survey of the Nicoya peninsula in Costa Rica's verdant north-west. This involved 119 sites in just one region, but it asked many of the same questions as the country-wide survey. Preliminary results show that the soundscapes of regenerating forests in Nicoya generally resemble those of intact forests much more closely than those of pastures or plantations. Delgado says this suggests Costa Rica's restoration is working for the whole ecosystem, not just the trees.

By comparing soundscapes in more detail at different frequency ranges and times of day, the researchers have also started spotting missing sounds – and unwanted ones. For example, certain high-frequency sounds that dominate pristine forests at night are absent in restored forests. Delgado thinks this could be due to missing amphibian diversity or other nocturnal species that don't do well in human-dominated landscapes. During the day, pastures and tree plantations show a spike in lower frequencies. Sounds from human activity, like motors and mooing cows, are the likely culprits there, says Delgado.

There are larger questions about how to reliably use sound as a measure of biodiversity. But research elsewhere suggests the chorus of vocalising species can say something about the ones that are mute. In October last year, Jörg Müller at the University of Würzburg in Germany and his colleagues used different measures of acoustic complexity to estimate biodiversity in dozens of forests in Ecuador. They used a series of "acoustic indices" that provide a generic way to compare the complexity of soundscapes without having to identify the individual species making sounds, as well as a machine-learning model that could identify some species of birds. They compared these audio indicators with genetic diversity measured among insects that were physically captured in the different forests.

The researchers found that the combination of acoustic indices could predict several aspects of biodiversity in the different forests, and that these correspond to what Müller calls an "acoustic signature" of an intact forest. The machine-learning model provided an even more reliable prediction of biodiversity in the different forests, despite it identifying only about a quarter of the bird species present. In other words, the sounds of a limited number of singing birds were enough to reliably predict the presence of silent insect species.

It remains to be seen whether these signatures of restoration hold true across many different types of ecosystem, says Müller. Determining that will require surveys like the one in Costa Rica. It will also mean collecting and labelling enough training data to build machine-learning models that can identify a greater diversity of species across all regions. "It's not a scientific question any more," says Müller. "It's a question of training data."

But Delgado's survey might also shed light on more theoretical questions about the sounds of ecosystems. For instance, Delgado, who has been known to spend weekends back home in Zurich in his hammock listening to forest sounds, thinks the soundscapes of pristine ecosystems may have qualities that people find more pleasing than degraded ones. He thinks these might even correlate with patterns we enjoy in music. "We're drawn to these places with sounds that are pleasing to us," he says. "And they're pleasing to us because they're good habitats."

Here in Costa Rica, however, the requirements of the survey leave him little time to luxuriate in forest sounds. "The microphones do my contemplation in the woods for me," says Delgado, as we head down yet another bumpy road. "I wish I could take their place sometimes." ▮

"The microphones do my contemplation in the woods for me"

"A global network of acoustic sensors could monitor the planet almost in real time"

SHUTTERSTOCK/CANDRA GUBTA

Like many marine animals, humpback whales use sound to communicate

James Dinneen is an environment reporter at *New Scientist*

Cosmic curveballs

We may be on the cusp of finding a new kind of gravitational wave signal that can reveal many of the universe's secrets, finds **Jonathan O'Callaghan**

DID you hear the one about the star that died twice? In 2014, astronomers saw the explosion of the Refsdal supernova. Then, 360 days later, it went bang again.

This bizarre sequence of events was down to a phenomenon called gravitational lensing, in which massive objects warp the fabric of space enough to cause light to bend. The path of the flash from the supernova was changed in this way on its journey to us, so that portions of it took different routes and arrived at different times – almost a year apart in this extreme case.

As that story shows, gravitational lensing has been around for a while, but now it is about to enter a compelling new chapter. Scientists know it isn't just light that can be lensed, but gravitational waves too. It is a mind-bending concept: ripples in space-time themselves being distorted by the curvature of space. It is also a deeply important phenomenon that could illuminate the secret interiors of neutron stars, settle a mystery about the power of dark energy and test gravity itself more keenly than ever. And here is the best part: we may be on the cusp of spotting our first lensed gravitational wave.

No one is under any illusions that this will be anything other than fiendishly difficult. Still, there is a sense it will happen sooner or later – and there are tricks we can pull to expedite the discovery. "It's exciting, and it's going to happen," says Simon Birrer at Stony Brook University in New York. "There's no way [these waves] don't exist."

When we gaze at space, it looks like empty nothingness. But for the purposes of cosmology, scientists think of it as space-time, which is as a bit like a stretchy sheet of fabric. Albert Einstein's theory of general relativity tells us that the more massive an object is, the more it warps this underlying fabric of the universe. Sudden, dramatic changes in mass – like when black holes collide – make the fabric ripple, an effect we call a gravitational wave.

These ripples were first directly detected by the Laser Interferometer Gravitational-Wave Observatory (LIGO) in the US in 2015. Its detectors work their magic by firing laser beams along two perpendicular arms, each 4 kilometres long. The detectors can sense a passing gravitational wave because it squashes and expands the space the arms occupy by a tiny amount, altering the distance the beams travel with respect to each other. That first detection was heralded as a huge breakthrough; a Nobel prize soon followed.

Since then, about 90 confirmed detections have been made in three observing campaigns. Each arose from a collision, or merger, between two neutron stars, two black holes or one of each. Some of the neutron star mergers are followed by super bright visible explosions called kilonovae. Observing the gravitational waves generated by the mergers has taught us much about the objects that cause them, including the distribution of their sizes. We have even detected the so-called gravitational wave background, a low-level hum of such ripples that emanate from the early universe.

LIGO is now in its fourth observing run, complemented by an additional detector in Italy, called Virgo, and another in Japan, the Kamioka Gravitational Wave Detector (KAGRA). We expect that hundreds of additional mergers will be detected in this run, which lasts until February 2025. There is even another detector, LIGO-India, set to open later this decade. In short, gravitational

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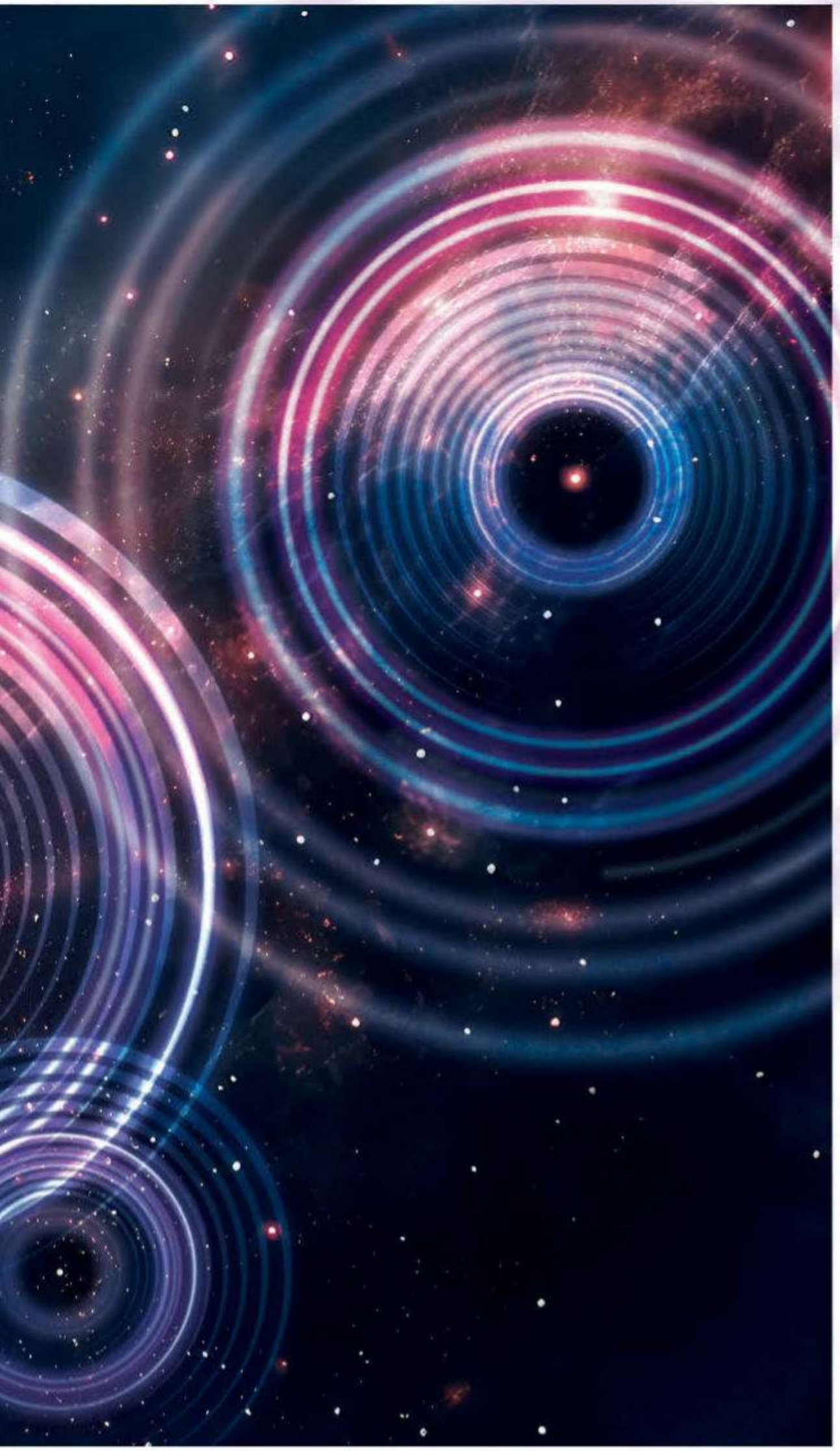


wave sightings are becoming routine.

But routine in this case is the opposite of boring. The more of these waves we see, the better the chance we have of snaring rare varieties. Like ornithologists waiting patiently in a hide, gravitational wave watchers feel they might soon catch a glimpse of a really uncommon bird.

In principle, a lensed gravitational wave works very much like a lensed ray of light (see diagram, page 42). A merger produces ripples in space-time that spread out in all directions. If there is some massive object like a galaxy cluster between the source of the ripples and Earth, it warps space-time and acts like a lens. This can bend some of the waves travelling roughly towards Earth, focusing them on us. With light, this can result in distorted or repeated images. Rarely, it can form an "Einstein ring", where the resulting image is a circle, which occurs when the source, lensing object and observer are all perfectly aligned.

With gravitational waves, the same applies – the wave can be distorted, magnified or even repeated, like an echo. "And that's just incredibly powerful for the science we can do," says Graham Smith at the University of Birmingham, UK.

Wait for it

How frequently should we expect to detect these strange echoes? In 2023, Smith and his colleagues ran the numbers and estimated that, at best, we might expect 1 in 1000 detected gravitational waves to be lensed. Given that we are expecting to see hundreds in the current observing run, we could, if we are lucky, see one at any moment. At a recent scientific meeting to discuss this, the consensus was that we will see a lensed gravitational wave within a few years. "You probably need a few hundred gravitational wave events before you're likely to get [a lensed one], which is kind of the ballpark we're getting into now," says Tessa Baker at the University of Portsmouth, UK.

It will be a big moment. Observing lensed gravitational waves should open up at least three new avenues in science. The first involves measuring the speed of gravity.

According to general relativity, gravitational waves should travel at the speed of light. Observing lensed waves would enable us to check this with unprecedented precision. Physicists are hunting for clues that might lead to a quantum theory of gravity, and deviations from general relativity could point the way. ›

The amount that the incoming gravitational wave signals are distorted could also give us key information about dark matter, the unexplained stuff thought to make up 85 per cent of the universe's material. Any intervening galaxy cluster would contain substantial amounts of dark matter, perhaps even in the form of clumps with the mass of planets, says Birrer. "Depending on how dark matter is structured, it will create an imprint in these waveforms." This could help us distinguish between different hypotheses for what dark matter is and how it behaves.

Even more excitingly, certain types of lensed gravitational wave may help resolve a persistent problem in cosmology known as the Hubble tension. We know the universe is expanding at an increasing pace, driven by a mysterious force called dark energy. Astronomers can measure this rate, known as the Hubble constant, in two ways. One involves analysing large-scale fluctuations in the cosmic microwave background radiation, which permeates the universe. The other looks at supernovae explosions that are relatively close to us. However, these methods give conflicting values for the expansion rate: about 73 kilometres per second per megaparsec (a megaparsec is about 3 million light years) in the local universe, but 67km/sec/Mpc on larger scales.

"Seeing a lensed gravitational wave may help us with several cosmological mysteries"

Observing a lensed gravitational wave would give us another way of measuring cosmic distance and therefore a third, independent measure of the Hubble constant that would have far less uncertainty than the other methods. "We know our current standard cosmological model is a bit broken," says Baker. "Either there's something that's been mismodelled or there's new physics." Observing a lensed gravitational wave wouldn't solve the Hubble tension overnight, but it would "add a very complementary measurement", says Birrer, helping us move towards a solution.

That is the good news. The bad news is that identifying a lensed gravitational wave just from the signal that LIGO detects will be taxing in the extreme. Searches for one in LIGO's back catalogue of detections have found nothing so far.

When light is bent around a gravitational lens, the resulting effect is obvious. The Refsdal supernova, named for Norwegian astronomer Sjur Refsdal, literally appeared in the sky twice. Not the sort of thing astronomers are likely to miss. A lensed gravitational wave will be subtle by comparison. The signals detected by LIGO are "chirps": a wave that sharply increases in amplitude and then tails off. Lensing could affect these in a few ways.

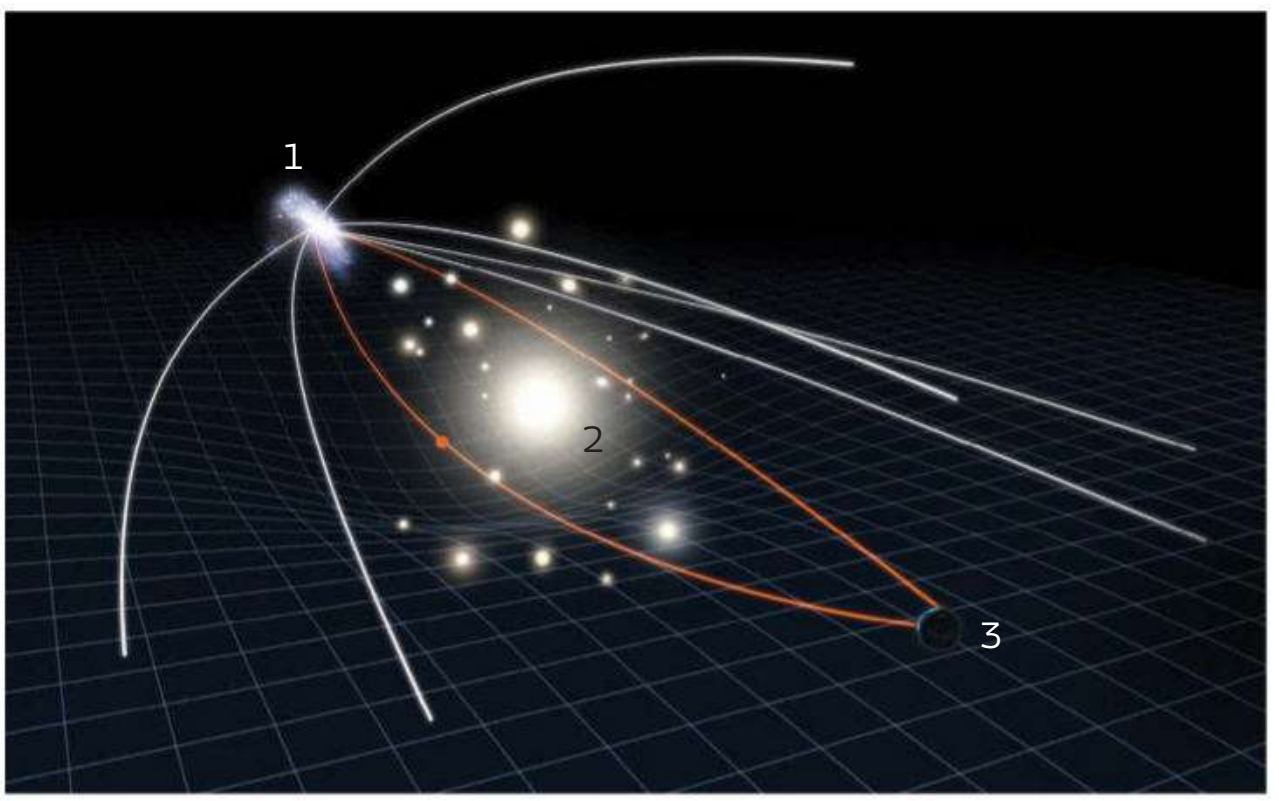
First, the lens could increase the amplitude, or strength, of the wave. The trouble is, that wouldn't be conclusive: there is no sure-fire way to distinguish between a lensed gravitational wave and one that just comes from a bigger or closer merger. "There are certainly scenarios where there is gravitational wave lensing, but the result would be inconclusive," says Otto Hannuksela at The Chinese University of Hong Kong.

Except there might be a workaround. We can deduce from LIGO signals the mass of the two objects involved in a merger that produces the gravitational wave seen. Based on all the confirmed LIGO detections so far, we think there is a "mass gap" between the heaviest neutron stars, at 2.2 times the mass of the sun, and the lightest black holes, which start at about five times the solar mass. If we spot a merger with progenitor objects that appear to be in this mass gap, we might be looking at a neutron star merger event that has been magnified by a lens to look bigger than it really is. "Some of them will get boosted [by lensing] and fall into this mass gap," says Anupreeta More at the Inter-University Centre for Astronomy and Astrophysics in India.

The second way lensing could affect gravitational waves is just to distort them in hard-to-anticipate ways. But the third way is much more promising. In special cases, the wave could repeat. In this case, we would get two almost identical chirps arriving one after another, with the delay depending on the mass of the lens. This would be much more of a smoking gun. Yet detecting any of these will rely on complex signal processing and interpretation. Which is why the gravitational

How gravitational lensing works

(1) Light rays from a bright object such as a galaxy spread in all directions; (2) These rays are bent by the gravity of a massive object, like a galaxy cluster; (3) Some rays (orange) arrive at Earth at different times or angles, creating distorted images. A similar process can affect gravitational waves (see main story)



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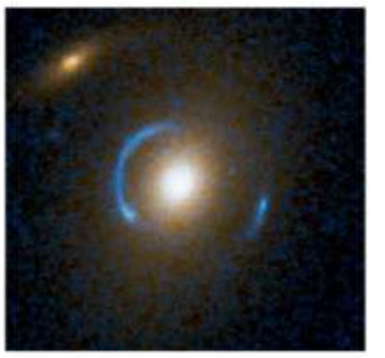

NASA, ESA, A. BOLTON, SLACS TEAM

An Einstein ring (above) is a telltale sign of the gravitational lensing of visible light. The Vera C. Rubin Observatory (left) could help us find the source of a lensed gravitational wave

echo hunters have another card up their sleeve.

To provide bulletproof evidence of a gravitational lens, astronomers would ideally find the lens itself – usually a galaxy cluster – and show that it lines up with the source from Earth's perspective. But LIGO's detectors can only narrow down the origin of space-time ripples to a fairly broad area of sky. So they want to recruit some help from a new telescope.

The plan is to try to spot the visible kilonova explosion emanating from the merger that produced the ripples. This arrives at Earth typically within about a day of the gravitational wave. Scanning the sky to find this in such a short time would be a tall order. But the Vera C. Rubin Observatory at the summit of Cerro Pachón in Chile is one of the world's most advanced telescopes. It is due to switch on at the start of 2025 and will use its 8.4-metre-wide mirror and a massive digital camera to snap vast images of the whole sky.

Catch the flash

Rubin's primary goal is to perform our most detailed survey of the night sky. Over 10 years, it is expected to image 40 billion cosmic objects. But in March, Smith met with the Rubin team to discuss whether the telescope could occasionally take a short break from its survey and try to find the visible counterpart of a lensed gravitational wave signal. Federica Bianco at the University of Delaware, Rubin's deputy project scientist, is keen on the idea and actively exploring it with Smith.

If and when Smith and his colleagues spot a likely looking lensed gravitational wave, they plan to notify the Rubin telescope. It will scan the sky to find the corresponding flash, then send the coordinates to space observatories, including the powerful James Webb Space Telescope, which can then watch in detail. The hope is that this whole process will be automated, with the multi-billion-dollar telescopic dance lasting just minutes.

Doing all this would help identify the lens itself, confirming the lensed gravitational wave was genuine. But it would also be crucial for unlocking some of the scientific possibilities of such a detection. For example, measuring the speed of gravitational waves will only be possible if we can pinpoint the source of those waves using Rubin. But beyond that, it would open up even more science.

Only one definitive kilonova has been seen before . That was in August 2017, when LIGO picked up a gravitational wave known as GW 170817 and astronomers managed to find and see the visible explosion that followed 11 hours later. "This first detection confirmed the origin of kilonovae can be these binary neutron stars," says More.

One reason studying kilonovae matters is because these explosions may be the only events powerful enough to create half the elements on the periodic table, those heavier than iron. That 2017 kilonova was the first and only time we have seen such elements being made – analysing the light given off showed us the individual signatures of each element.

But we only caught the tail end of the explosion. For Smith and his colleagues, the dream is that a lensed gravitational wave could give us early warning of a kilonova, which we could then watch from start to finish with telescopes. That could paint a complete picture of element synthesis and potentially answer the important questions we have about how it works, including whether kilonovae produce enough of the heavier elements to account for the amounts we see in the universe or if there must be another source.

The same visible signal could contain answers to fundamental questions about how nuclear material behaves at extremes. A neutron star, as the name suggests, is a blob composed almost exclusively of neutrons compressed to incredible pressure. Elsewhere, neutrons are normally embedded in atoms, and physicists have hypotheses to describe how they behave – but it is usually impossible to test them beyond standard atomic pressures and arrangements.

Neutron stars are the one place we can push far beyond this. Again, studying the flash from a kilonova could show us how the neutron stars react as they slam together, by extension telling us about the neutrons within. "They are about the only place in the universe where this is possible, so it is a big deal," says Matt Nicholl at Queen's University Belfast in the UK.

To see both the lensed kilonova and the lensed gravitational waves from the same merger requires both LIGO and Rubin to operate simultaneously, which may not happen for a few years yet. "We will be waiting till around 2027 or 2028," says Smith. Still, there is always the possibility we might see hints of a lensed gravitational wave before that just in the LIGO data. If this does arrive, ambiguous though the detection might be, it would be a thrilling moment of potential scientific discovery. "We need to be ready," says Smith. ▮

Jonathan O'Callaghan is a reporter focusing on space, based in the UK

The back pages

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Feedback
Spilling the beans on beans, plus the fruits of melon science p48

Twisteddoodles for *New Scientist*
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Dear David

Friends reunited

Reigniting old friendships is easier than you might think, says **David Robson,** in his new evidence-based advice column

David Robson is an award-winning science writer and the author of *The Laws of Connection: 13 social strategies that will transform your life*, out on 4 June in the US and 6 June in the UK

Dear David, an evidence-based advice column, appears monthly. Drop David a line with your social dilemmas at davidrobson.me/contact.

Next week
Stargazing at home

WHEN I tell friends I have written a (forthcoming) book about social connection, one of the most common questions I get is about "lost" friendships. They regret that they are no longer in contact with people who were once part of their lives. Should they make the first move to get in touch, or accept that some relationships are better left in the past?

The desire to reconnect is often balanced by a fear of being rebuffed, but two recent papers have convinced me that we can all be a bit braver about reaching out.

The first comes from Peggy Liu at the University of Pittsburgh in Pennsylvania and her colleagues. The team asked participants to provide the name and email address of a person with whom they hadn't been in touch for a while. They then wrote a note to that person and answered some questions about how much they thought the friend would appreciate the gesture. The researchers forwarded the note to the named person, along with a questionnaire asking them about their feelings. Their results should be good news for anyone who wishes to reach out to their old friends: the recipients welcomed the notes far more than the authors had anticipated.

The second paper is by Lara Aknin at Simon Fraser University in Canada and Gillian Sandstrom at the University of Sussex, UK. They found that as many as 90 per cent of people have lost touch with at least one old friend, but many are now reluctant to make the first

TOMAZL/GETTY IMAGES

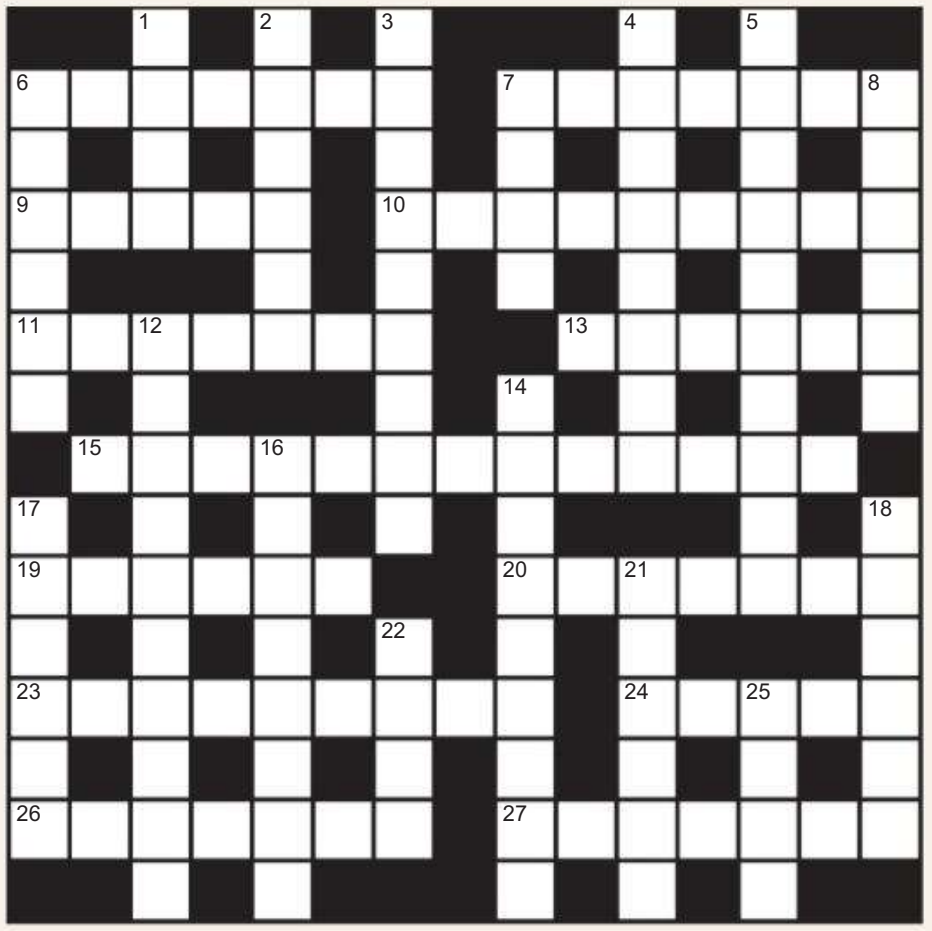
move – even when researchers gave them the time and resources do so. Probing deeper, they found that this reticence arose from various concerns: the participants worried about what to say to rekindle the friendship, and they feared that the friend had changed and that they would no longer have the same connection.

The old friends, it seemed, had started to feel like strangers, and this led Aknin and Sandstrom to wonder whether a little practice at building new ties might give people the confidence to strengthen their older ones too. Sure enough, they found that asking people to strike up a conversation with strangers meant that they were considerably more likely to reach out to their oldest acquaintances. Our social confidence, it seems, is like a muscle – the more we use it, the stronger it becomes, and those benefits can spill over into many different contexts. We just need to have the courage to start.

I am so excited about our potential for connection that I would love to answer some of your questions about living socially in future columns. Think of me as your scientifically informed advice columnist. Let me know the social dilemmas you face at davidrobson.me/contact, and I will plumb the depths of the psychological literature for evidence-based strategies to overcome them. ▮

These articles are posted each week at newscientist.com/maker

Quick crossword #158 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

6 University department (7)
7 Of a birth, premature (7)
9 Joseph ___, British botanist, born in 1743 (5)
10 It may be alpha, beta or gamma (9)
11 Spotted big cat (7)
13 Nut tree in the subgenus *Amygdalus* (6)
15 Common contagious virus (6,7)
19 Population survey (6)
20 Bird of South America, related to the extinct moa (7)
23 Blister caused by cold (9)
24 - (5)
26 Pad that supports a surgical suture (7)
27 O, Fe, Ne or Cl, for example (7)

DOWN

1 Screen pictogram (4)
2 Fundamental state of matter (6)
3 Crossbreed (9)
4 10^{12} floating point operations per second (8)
5 Abdominal cavity membrane (10)
6 Bone of the lower leg (6)
7 Cushions (4)
8 Elementary substances, for Liebniz (6)
12 RMS Queen Mary, for example (5,5)
14 Seawise Giant, for example (3,6)
16 Leadwort (8)
17 Frozen polar region (3,3)
18 Group within a group (6)
21 1 or 2 or 3 or 4 or... (6)
22 SI unit of power (4)
25 Quiescent sleep (initialism) (4)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #252
set by Bethan Ackerley

1 Which of the following isn't a stress hormone: somatostatin, cortisol or norepinephrine?

2 Meliponiculture is the farming of which animals?

3 What is the primary mineral that makes up tooth enamel?

4 Axions, hypothetical elementary particles, were first proposed to solve which problem in quantum chromodynamics?

5 Cocci bacteria share what aspect of their appearance?

Answers on page 47

BrainTwister
set by Mary Ellis
#20 Factor-finding mission

154 has three prime factors (2, 7 and 11), but it can be divided by other numbers, including 1, 14, 22, 77 and 154. These are factors of 154, but not prime factors.

What is the smallest number that has four distinct prime factors? How many factors does this number have?

What is the next number after this that has the same total number of factors? (Hint: it isn't a number with four distinct prime factors!)

What is the smallest number that has that same total number of factors?

Solution next week

Child's play

At what age would a human child be capable of surviving in the wild?

Simon Ritchie
Leatherhead, Surrey, UK
Age isn't the issue. It really depends on how wild the area is. Members of hunter-gatherer communities have to be very skilled to survive in their environment. People without those skills wouldn't last long in such places without help.

When the fictional Robinson Crusoe was stranded on a desert island, he had a shipload of useful equipment, including food, woodworking tools, a gun and ammunition. Without all that, he would have starved fairly quickly.

Lucy Irvine's book *Castaway* (later made into a film) is the true story of her and her husband arranging to be stranded on a deserted island for a year. They took some food with them, but their plan to grow more wasn't very successful. When a boat eventually arrived with aid, they were in very poor shape. They hardly knew each other at the start – they had to get married to be allowed onto the island together. In a radio interview I heard, Irvine suggested

"When the fictional Robinson Crusoe was stranded on an island, he had a shipload of useful equipment, including food"

that anybody thinking about a similar trip should start by going on a camping holiday in Scotland and see how that goes.

Simon McLeish
Lechlade, Gloucestershire, UK
Where is the child? Assuming only earthly locations, the poles and equatorial deserts would be extremely hostile to anyone. Even more temperate environments can fairly rapidly lead to death from exposure or natural hazards, such as predators or the consequences of falls.

JENS ICKLER/ALAMY

This week's new questions

Tick tock **How do you check the accuracy of an atomic clock "that will lose less than 1 second every 40 billion years", as per a recent *New Scientist* article?** ***John Grant****, Sydney, Australia*

Over the edge **Why, if an unfastened duvet cover is put into a washing machine, does it bag up all the other items in there to be washed?** ***Anne Hayes****, Forest of Dean, Gloucestershire, UK*

What will the child be equipped with? Without means of obtaining food – such as a knife, fish hooks and twine, a handbook of edible plants or the tools to make a spear or a bow and arrows – starvation would follow.

What knowledge can the child be expected to have? I presume giving them a survivalist guide is out of the question. Medical information suited to a wild environment would have to be available to address threats like eating poisonous or spoilt food, as well as sunburn or frostbite.

One of the most interesting books I read as a child was Jean George's *My Side of the Mountain*, about a 12-year-old boy living alone on a US mountain. Here, he finds shelter in a hollow tree, with a falcon and weasel as companions. He was – just – able to survive for months. But that is fiction.

Guy Cox
Sydney, Australia
That clearly depends on what the child in question knows about survival skills. Going back to former hunter-gatherer societies, children were taught hunting and foraging skills from a very young age. By ages 10 to 12, they knew how to make fire and so could probably survive.

If you were to take a city kid of the same age to the wild, their chances would be zilch, unless they had learned survival skills.

John Davidson
Ballina, New South Wales, Australia
Before I started school, I spent a lot of time on my own pottering around in the forest and creek area at the front of where we lived. It was too small for me to get lost. The only dangers were snakes, a threat I understood.

I found a bit of bush tucker in here, but not enough to support me. There was also no escaping the weather. Our home was the back-up for food, shelter and safety. I guess I could have safely spent a night there if I had to. However, it may have been a bit scary.

By contrast, many Aboriginal Australian children once had a different experience. For example, young children and older girls spent their time with women as they collect food, medicines, etc. The older boys spent time with men learning hunting, tracking and other skills. A common feature of many Aboriginal societies was that when young men were old enough, they were expected to leave the group for a while and use their skills to survive for a specified period.

How do you check the accuracy of an atomic clock over a 40-billion-year period?

Playing it cool

Is it more efficient to leave the fridge briefly open when I am pouring milk for my tea or to close and reopen it, given warm air is introduced whenever the fridge door is opened?

Nick Baker
Colchester, Essex, UK
As the door opens, the cold, heavy air will flow out onto the floor, drawing in the room's warm air from above. Within a few seconds, there will be a steady down-flowing convection current. Even quicker than that, the warm surfaces of the room will start radiating energy (in the form of infrared radiation) to the surfaces of the fridge's contents. The rate of heat gain by these two mechanisms is of the same order of magnitude, around 100 watts. Closing the door will stop these instantly.

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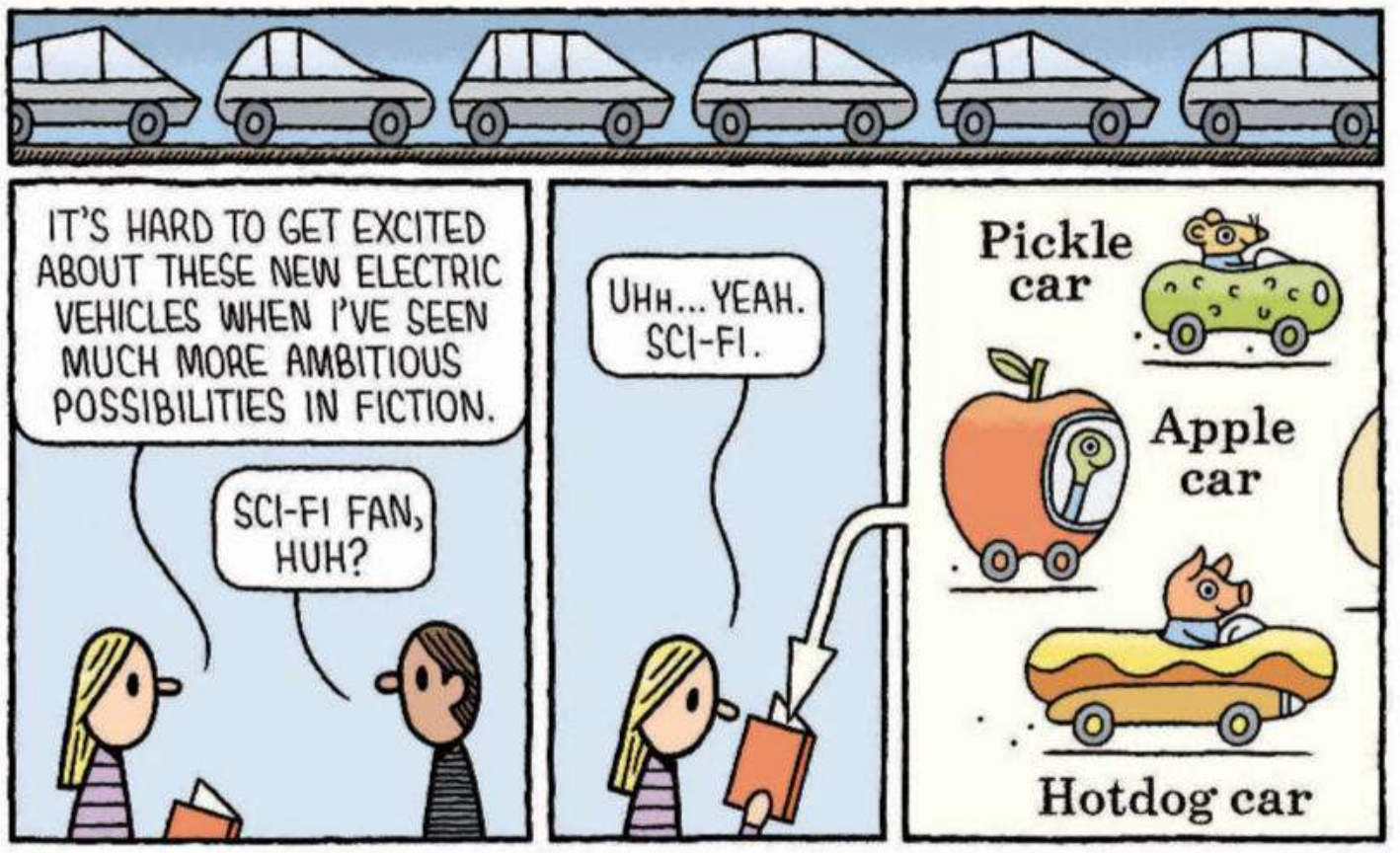
Tom Gauld
for New Scientist


IT'S HARD TO GET EXCITED ABOUT THESE NEW ELECTRIC VEHICLES WHEN I'VE SEEN MUCH MORE AMBITIOUS POSSIBILITIES IN FICTION.
SCI-FI FAN, HUH?
UHH... YEAH. SCI-FI.
Pickle car
Apple car
Hotdog car

Air has a very low volumetric heat capacity, so the amount of heat in the trapped warm air will be tiny compared with "coolth" (i.e. the opposite of warmth) stored in the cold contents. But even if it were significant, leaving the door open would just lead to several fridgefuls of warm air rather than one or fewer, plus more radiant gain. Doing this would be like drilling a hole in the hull of your leaky boat to let the water out!

Howard Bobry
Port Townsend, Washington, US

It makes very little, if any, difference because any exchange of cold fridge air for warm room air is insignificant. The interior of the fridge includes solid metal, glass and plastic components and containers, as well as various foods and liquids. These all have a far higher heat capacity than air, so even a complete exchange of all the chilled fridge air for warmer room air would result in negligible change in food and drink temperatures.

"Leaving the fridge open when pouring milk for tea would be like drilling a hole in a leaky boat to let the water out"

Maurice Gallagher
London, UK

It is more efficient, better for your health and more environmentally friendly to give up on milk and drink black coffee.

Dog legs

Unlike me, my dogs bound up hills as easily as they run on the flat. Does having four legs aid with climbing, or are the dogs just fitter than me? (continued)

Penelope Reid
Loggerheads, Staffordshire, UK

In my experience, the number of "legs" does make a difference. After experiencing nerve damage, I lost almost all my muscle mass and was reduced to crawling to get up stairs. Now, as I improve, I walk with a staff or two tall poles for balance and weight loading. I find I can use either to double my (limited) speed by pulling myself forwards using my stronger arms either front bounding (when both poles go forwards together) or striding. Sadly, my legs only manage striding. Walking sticks are nothing like as effective at utilising my arm strength with a staff or tall pole, grasped at just below shoulder height.

When we are on woodland walks, some of the dogs we meet seem to recognise I am a fellow four-legged walker and therefore worthy of more attention than my less weird husband.

Martin Murray
Lightmoor, Shropshire, UK

Dogs, like many animals that chase and pounce on their prey, have strong, flexible backs. A dog romping up a hill is using almost all its skeletal muscles, while we walk behind with our arms dangling uselessly and our backs just keeping us upright. No wonder it is no contest. ▮

Answers

Quick quiz #252 *Answers*

1 Somatostatin
2 Stingless bees
3 Hydroxyapatite
4 The strong CP problem
5 They have a round shape

Cryptic crossword #135 *Answers*

ACROSS 7 Helium, **8** Miaows, **9** Knob, **10** Teething, **11** Founder, **13** Comfy, **15** Taste, **16** Stirrup, **18** Superman, **19** Arch, **21** Walrus, **22** Indium

DOWN 1 Fern, **2** Big bang theory, **3** Smitten, **4** Amber, **5** Wash your hands, **6** Swine flu, **12** Oracular, **14** Utensil, **17** Amiss, **20** Crux

#19 Angular arrangements *Solution*

Each angle in the pentagon's centre is 360°/5 = 72°. Since a triangle's angles add to 180°, the two outer angles add up to 180° - 72° = 108°, so the regular pentagon's interior angles are all 108°. For a polygon with n sides, the centre angles would be 360°/n, so the interior angles would be 180° - (360°/n). The interior angles of sets of regular polygons that meet at a point must add to 360°. We can depict these sets using arrays like {3,3,3,4,4}, which represents three equilateral triangles and two squares. The possibilities are {3,3,3,3,3,3}, {3,3,3,3,6}, {3,3,3,4,4}, {3,3,6,6}, {3,3,4,12}, {3,4,4,6}, {3,12,12}, {3,10,15}, {3,9,18}, {3,8,24}, {3,7,42}, {4,4,4,4}, {4,8,8}, {4,6,12}, {4,5,20}, {5,5,10} and {6,6,6}. The maximum number of sides is 42. A 42-gon with a triangle and heptagon makes 360°. Past this, summing to 360° is impossible.

Full of beans

On a gut level, what happens after a person becomes full of beans?

Flatulence is what happens. But attempts at mitigation, explain Iowa State University researchers Donna Winham, Ashley Doina and Abigail Glick, can bring medical risk. They presented a paper at a recent conference in Denver, Colorado, called "Anti-flatulence supplements raise blood glucose after bean-based meals". The particular supplement they tested, alpha-galactosidase, "reduces gas production by breaking complex carbohydrates into smaller, less fermentable, components [but it] can significantly increase glycemic response even in healthy adults". Fewer farts, but at the expense of higher blood sugar levels.

The notion that bean-eating induces flatus underwent testing decades ago. F. R. Steggerda's noticeable 1968 paper "Gastrointestinal gas following food consumption" reported: "To establish the theory that when one ingests bean products he experiences flatulence, a number of experiments were performed in which the effects of a non-gas-producing basal diet were compared with those of a diet containing a high concentration of beans."

Steggerda added a memorable two sentences to the world's scientific literature: "The average gas volume collected per hour for the non-gas-producing diet was 15 cc, but when the diet was 57% pork and beans, the gas volume increased to 176 cc / hour... It was also observed that the gas-producing ability of Boston baked beans was not appreciably different from that of the pork and beans."

A year later, Alan Greenwald, Thomas Allen and Richard Bancroft at the United States Air Force School of Aerospace Medicine published a study indicating the heights to which bean-to-flatus production can rise. Their paper "Abdominal gas volume at altitude and at ground level" may long be remembered for its own literary contribution, in a terse section that discusses "the increase in body volume after ingestion of 0.6 kg of commercially available canned baked beans". The paper says: "The subject in this study agreed to retain abdominal gas for as long as possible thereafter."

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Survival of whistling

"Whistling," a study called "The spiritual exploration of the whistling art in China" reminds us, "has the function of expressing personal emotions and lifting the mood". Yet, explain authors Su Wang and Qingqing Xiao, the practice barely survived a Long, Dark Age of Whistling.

They present stark facts: "From the Song dynasty (960–1279 AD) to the Jin dynasty (1115–1234 AD), due to the constraints of feudal Neo Confucianism... at that time, only very few people liked whistling, and it basically disappeared. Although the development of whistling in the Yuan, Ming, and Qing dynasties was difficult to compare with the Wei and Jin dynasties, it also had its own development characteristics."

The study makes clear how extraordinary were the Wei and Jin periods: "During the period of the Wei and Jin dynasties, the great scholar Ruan Ji actively learned from the Taoist master Xiao Gong, enabling him to transition from a god to a human, thus adding an artistic masterpiece to the life of scholars."

Fruit, now like flies

Even before scientists discovered that a chemical called DNA transmits genetic information from generation to generation of all known living things, much of our understanding of inheritance came from fruit flies. Fruit got less attention. Now, things are catching up for fruit. Especially melons.

Flies had the advantage, for geneticists, of reproducing more quickly than most plants do. Data about fruit fly reproduction accumulates faster and more copiously than reproduction data about rice or roses. Or melons.

Hari Kesh at CCS Haryana Agricultural University in India and Prashant Kaushik at the Technical University of Valencia in Spain describe the metaphorical fruits of this catching-up in their study "Advances in melon (*Cucumis melo L.*) breeding: An update". As they say, "significant information on melon genomics, and melon metabolomics, is advantageous for dissecting the inheritance of quintessential traits".

Kaushik is, in a way, a fine example – a human fruit fly, if you will – of high-rate productivity. During the first three months of 2024 he published, as author or co-author, at least seven research studies. In a meaningless-but-mentionable comparison – Kaushik's literary production rate versus the biological production rates of melons and fruit flies – he ranks intermediate between the plants and the insects.

Mourning dead slogans

A very few slogans stand as fading testimony to the good intent of the people who ran a particular organisation. Two of the most outstanding are IBM's "THINK" and Google's "Don't be evil".

Those have both been retired. Presumably, each retirement marked the discovery of a nobler ideal. Something more profitable for humanity, or a portion thereof.

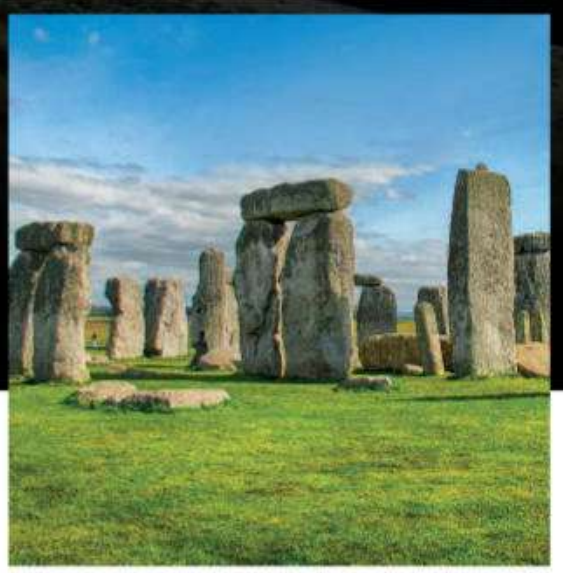
Feedback would enjoy learning about other inspirationally commendable organisation slogans that were supplanted. If you know of one, don't be evil and keep it to yourself. Instead, please send it (with documentation) to feedback@newscientist.com. ▮

Marc Abrahams

Discovery Tours

NewScientist

Short breaks for curious minds

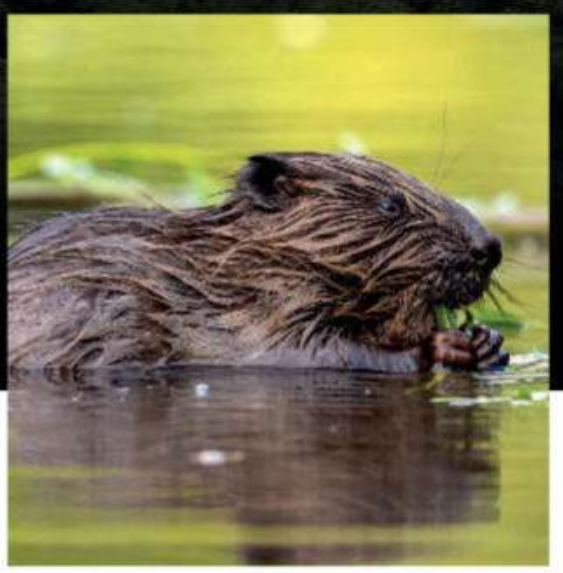


Human origins: prehistoric south-west England

15 July 2024 | 5 days

Be immersed in the early human periods of the Neolithic, Bronze and Iron Ages on our gentle walking tour that explores the prehistoric origins of Wiltshire and Dorset. From complex Iron Age hillforts, ancient stone circles and some of the area's most beautiful landscapes, discover this quaint region of south-west England.

- **Visit several National Trust, English Heritage and UNESCO listed sites, including Stonehenge, Old Sarum, Avebury and Maiden Castle.**
- **Joined in Cerne Abbas by former *New Scientist* editor-in-chief Emily Wilson, who will lead a guided walk around the prehistoric landscape.**
- **Talks from the directors of the Salisbury and Wiltshire museums offering an insight into what life was like during this period.**

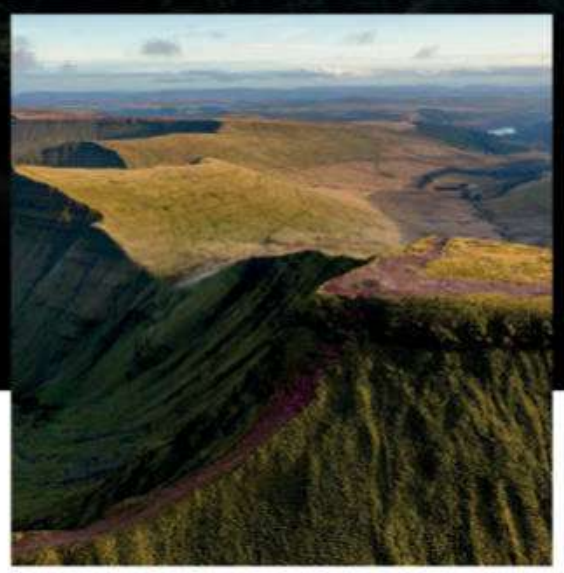


The science of rewilding: Coombeshead, Devon

16 August 2024 | 3 days

A unique opportunity to stay at the heart of Rewilding Coombeshead, a conservation-in-action project nestled deep in the beautiful Devon countryside with Dartmoor and Bodmin moor as your backdrop. Witness the project's "rewilding helpers", such as water buffalo, wild boar, mouflon sheep and Exmoor ponies, in action and join leading ecology experts to learn about the history of rewilding, how rewilding is becoming a global phenomenon and the native species that are being reintroduced to the British countryside.

- **Learn more about the process of rewilding and how it can be used to repair damaged ecosystems and restore natural landscapes.**
- **Attend lectures in in a converted agricultural barn, which also houses a camp canteen and bar.**
- **Join a walking safari of the 160-hectare rewilded site.**



The science of deep time: Brecon Beacons, Wales

9 September 2024 | 3 days

Join us in beautiful South Wales, where you will stargaze back through time, journey deep underground in caves, climb mountains and hear from a range of experts who will immerse you in the latest in deep time thinking.

Staying in the unique Craig Y Nos, an 1840s gothic castle, surrounded by a lush country park in the Brecon Beacons, you will gain an appreciation and understanding of the timelines and processes involved over millennia, and the very small amount of space and time we occupy within it.

- **Talks and walking seminars from geologists, astronomers, palaeontologists and deep time advocates.**
- **Visit awe-inspiring caves and mountains.**
- **Learn about our place in the cosmos through expert-led stargazing.**

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